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# SOLID WASTE MANAGEMENT IMPLEMENTATION PROJECT

## SAN FRANCISCO BAY AREA

**Summary**

ABAG
ASSOCIATION
OF BAY AREA
GOVERNMENTS

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# THE BAY AREA SOLID WASTE MANAGEMENT IMPLEMENTATION PROJECT

## SUMMARY REPORT

A Report Prepared for the Action Committee for
the Bay Delta Resource Recovery Demonstration
and the Association of Bay Area Governments

December 1973 by

ENVIRONMENTAL IMPACT
PLANNING CORPORATION
SAN FRANCISCO, CALIF.
eip

In association with Frank Stead

ABAG ASSOCIATION
OF BAY AREA
GOVERNMENTS

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December 14, 1973

Mr. Revan A. F. Tranter
Executive Director
Association of Bay Area Governments
Claremont Hotel
Berkeley, California 94705

Dear Mr. Tranter:

In the fall of 1972 a group of local agencies in the San Francisco Bay Area joined together in an attempt to initiate a Demonstration project to test the feasibility of using composted organic solid wastes in the low-lying islands of the Sacramento-San Joaquin Delta for levee stabilization, land building and agricultural purposes. These local agencies, calling themselves the Bay Delta Resource Recovery Action Committee, also sought to develop the intergovernmental institution necessary to manage this Demonstration project and perhaps to become the regional agency charged with solid waste management. This report documents the efforts of these local entities, acting voluntarily, to attempt to improve the technical and governmental mechanisms operating in the field of solid waste management today.

The report is presented in three volumes. Volume 1 describes the preliminary system design for the Demonstration project and looks at the concept of Bay-area wide implementation of the plan. It also details the possible institutional mechanisms necessary to implement the plan. Volume 2 is an environmental evaluation of the Demonstration project and is written in the format of an Environmental Impact Report. Volume 3 contains two technical reports upon which the preliminary system design was based. Part A is a study of the structural characteristics of compost and an evaluation of the feasibility of using compost as a levee strengthening material. This report, prepared by Drs. Duncan and Seed of the Engineering Department of the University of California, Berkeley, represents original research on this subject. Part B documents the preliminary compost experiment conducted by Dr. Samuel Hart at Davis, California, and includes recommended composting specifications for the Demonstration.

The consultants wish to thank the members of the Action Committee and its chairman, Councilman Fred Maggiora, for making this report possible. We would also like to thank the U.S. Army Corps of Engineers (San Francisco and Sacramento Districts), the

Mr. Revan A. F. Tranter
December 14, 1973
Page 2

California Department of Water Resources, the Central Valley Regional Water Quality Control Board, and the California Water Resources Control Board for their valuable contributions. Further, we would like to thank the Sierra Club, the League of Women Voters and the San Francisco Planning and Urban Renewal Association, as well as the many public and private organizations and individuals who participated in this study.

Yours very truly,

and Frank M Stead

Hans A. Feibusch, P.E.

Frank M. Stead

## SUMMARY REPORT

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## FOREWORD

For over two hundred years this country has operated under a "cowboy economy"--throwing its natural resources away after one-time use. Now, as we consume more and more of these resources we are beginning to see the bottom of the barrel, not only for metals, minerals and wood products, but for fossil fuels as well. So we now find ourselves in danger of running out of both materials of manufacture and construction and sources of fuel. Our response has been to look at solid wastes as a new kind of ore and a new kind of fuel, and this is unquestionably a great step forward.

But at the same time we have been steadily "consuming" our most important resource of all--topsoil--the very basis of the support system for plant and animal life without which man cannot exist. We ship huge crops of vegetable foods and plant-fed animals to cities. Most of these organic materials taken from the soil are never put back. In addition, we allow wind and water to erode away topsoil, we cover it over with highways and cities, and we strip it away to more easily get at large deposits of coal and other mineral resources.

The natural replacement of lost topsoil is amazingly slow. Nature takes from 500 to 1,000 years to make one inch of topsoil. Our deepest concern, therefore, should be to halt, or at least slow down, this steady depletion of the country's soil mantle.

In the Bay Area nearly ten million tons of solid wastes are generated each year. Bay Area wastes that are collected are hauled by truck for burial in soil-covered disposal sites. Some sites are well engineered and operated so as to prevent health hazards, nuisance, and water pollution, but many are not. At the same time, at the north end of San Francisco Bay, where the Sacramento and San Joaquin Rivers merge, a delta of numerous scattered islands of peat exists. The Delta islands were diked against water intrusion during the early part of the century and include 500,000 acres of intensively cultivated agricultural lands. However, the islands have been sinking at the rate of two to three inches per year and are now ten to fifteen feet below sea level. Many of the dikes are weak and subject to frequent rupture as occurred dramatically in June 1972, when Andrus and Brannan Islands were inundated. If this situation is allowed to continue, loss of most of these valuable agricultural lands is virtually assured.

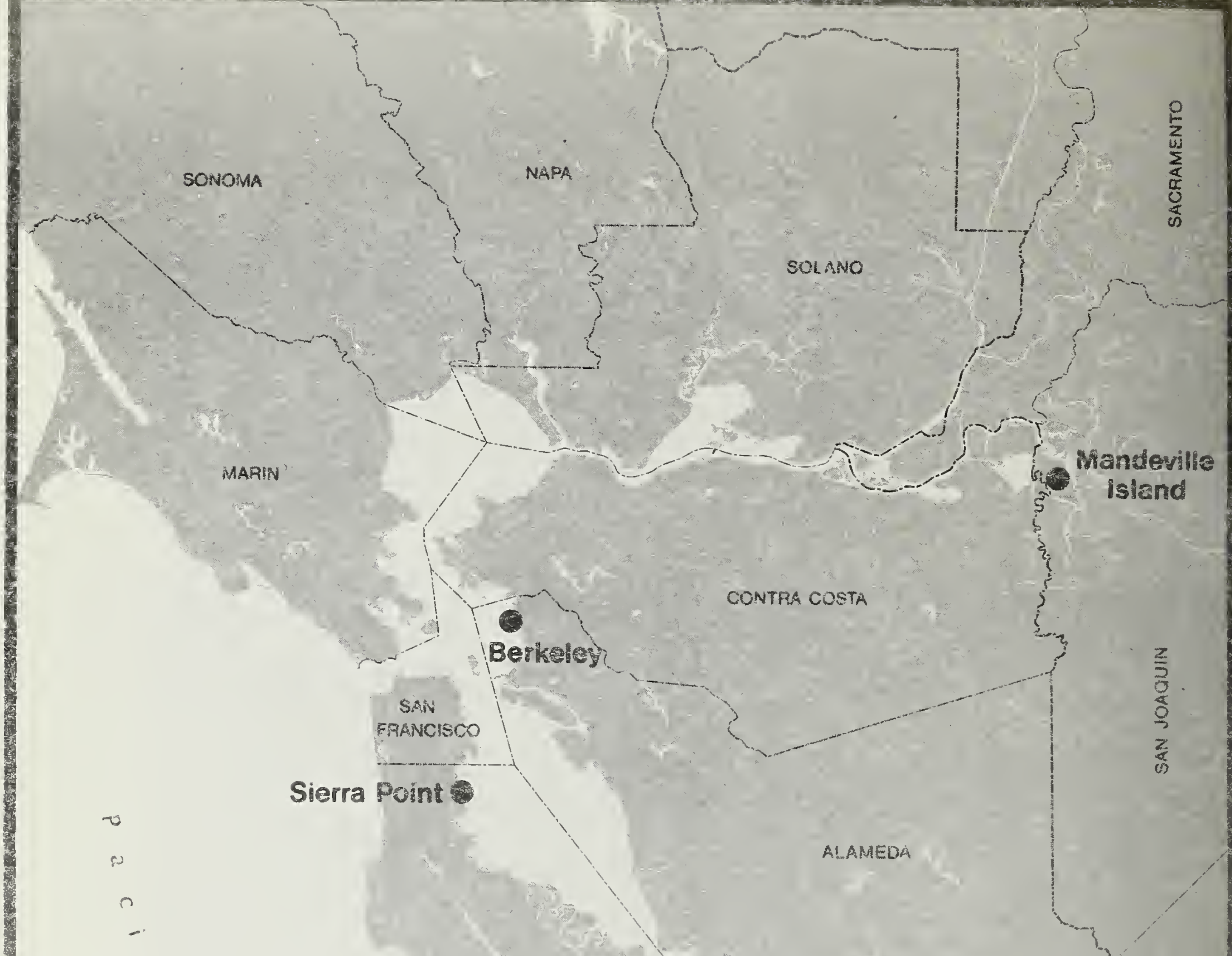
Several years ago the San Francisco Planning and Urban Renewal Association (SPUR), after a two-year study, proposed a mutual solution to the solid waste and Delta land subsidence problems. A pilot-scale Demonstration project was recommended to test this proposal (The Bay Delta Resource Recovery Demonstration).

The Demonstration is dedicated to the long range goal of returning to the land the materials from which topsoil is made--namely, the humus produced by bacterial decomposition of plant and animal residues. It would convert the organic portion of municipal refuse into a compost closely resembling natural peat soil. Compared to the conversion of solid wastes into combustible fuel supplies by incineration or pyrolysis, composting is a form of energy recovery occurring in the biological realm. The energy of organic materials in compost supports microbial action which efficiently stores and releases nutrients in the soil.

The peat islands of the Sacramento-San Joaquin Delta were selected as the site for the Demonstration because they illustrate an extreme case of topsoil erosion--caused in this case by the combined effects of wind and auto-oxidation. The islands also afford an unprecedented opportunity to compare directly the fertility of manmade topsoil with highly fertile natural Delta peat.

Because the Delta islands are in imminent danger of extinction by flooding, the first placement of compost will be in the form of a wide berm to physically buttress the levees. Later phases envision application of compost to the entire floors of the islands.

The vast agricultural area of the Delta has the capacity to assimilate the entire output of organic materials from the San Francisco Bay Metropolitan Region on a perpetual basis. Thus, the Bay-Delta Demonstration may well be the harbinger of a truly revolutionary change. We can perhaps turn from a system which diminishes our natural resources and increases our mountains of waste to a system in which the most valuable resource of all--the land--is preserved in undiminished productivity forever.



# Regional Location

## Bay Delta Resource Recovery Demonstration Project

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# I. SUMMARY AND CONCLUSIONS

## A. INTRODUCTION

This project has as its base the 1971 Report of the San Francisco Planning and Urban Renewal Association entitled "A Solid Wastes Management System for the Bay Region." Commonly known as the Bay Delta Plan, that report called for regional management of solid wastes; a maximum recovery of resources from the solid wastes stream; and a proposal to use the organic portion of municipal refuse for island reclamation in the Sacramento-San Joaquin Delta.

A three-phase program toward regional solid waste management was recommended. In Phase I, the planning would occur for a pilot scale Demonstration to test the concept of separating wastes and transporting the composted organic portion to the Delta islands. An intergovernmental structure would be formed to secure funding for and to manage the Demonstration project. In Phase II the Demonstration would be conducted, and in Phase III the Bay Area could move into permanent, full-scale operation of a regional plan.

Two years of effort by a few dedicated public officials and private citizens resulted in the formation of the Action Committee for the Bay Delta Resource Recovery Demonstration under the sponsorship of the Association of Bay Area Governments (ABAG) to carry out Phase I. The Action Committee developed into a diverse and dynamic coalition of elected officials, public administrators, engineers and concerned citizens representing large and small cities, rural and metropolitan areas, utilities and the private sector of the solid wastes industry.

Although such a broad range of interest often results in cautious progress, it is certainly the most deliberate and responsible way to proceed in planning for any regional solid waste management program.

The planning study focused on three basic areas. First, intergovernmental arrangements were explored to manage the Demonstration project on behalf of the political jurisdictions of the Bay Area. It was thought that these arrangements might serve as a first step to regional cooperation and eventual regional management of solid waste. Second, a preliminary system design was developed for the Demonstration including selection of participants, design of a monitoring program, economic analysis and an environmental evaluation. Finally, the concept of full-scale implementation of the plan in the Bay Area was investigated in terms of its costs and technical, environmental and political feasibility.

The results of this study suggest a number of areas of concern. The formation of an intergovernmental agency to manage the Demonstration has been slow and continued efforts will be required to achieve a final welding of this institution. Feasibility studies indicate that placement of compost behind Delta levees may cause cracking of the levees, and leachates from the compost may have adverse effects on water quality and wildlife in the Delta sloughs. Also, full-scale implementation of the project is likely to result in a high per mile cost of buttressed levee. However, no obstacles have been identified which seem to be insurmountable and it is clear that a pilot scale Demonstration project offers the best opportunity to answer the questions which have been raised. In view of the exciting potential of this program for solving a major portion of the solid waste disposal problem and for contributing to the stabilization of Delta levees, the pilot scale Demonstration should proceed as rapidly as possible in order to test the validity of this plan.

## B. REGIONAL SOLID WASTE MANAGEMENT

According to the SPUR report, an essential element of the plan includes the management of solid wastes on a regioal basis. Only on a region-wide basis can a resource recovery plants of economical size be developed and efficient transportation routes be established. Perhaps most importantly, only on a regional basis can the intergovernmental agreements be developed which are necessary for large scale land reclamation in the Delta.

A regional waste management plan should be carried out in accordance with the following principles:

a. A new governmental entity is needed to carry out a region-wide wastes management program for the Bay Area.

b. To the greatest extent feasible, private enterprise should be encouraged to undertake all aspects of solid wastes management--collection, resource recovery and disposal.

c. Inventive proposals to carry out aspects of the regional plan should be encouraged, and should be evaluated on the basis of their conformity to the regional plan.

An intergovernmental entity is needed for regional management of solid wastes for the following reasons:

a. to manage demonstration projects that would have region-wide application;

b. to solicit and accept funding from state, federal and other sources;

c. to allocate costs fairly among local jurisdictions;

d. to plan comprehensively, including transportation and land use as well as waste processing and disposal;

e. to facilitate inter-county transfers of waste materials;

f. to make a systems approach to resource recovery more feasible;

g. and finally, to eliminate the need for direct federal and state controls.

An ultimate regional solid wastes management entity, regardless of its form, should have the following powers and duties:

a. to arrange for the processing of the region's solid wastes;

b. to arrange for the building or leasing of a system of regional processing/transfer stations and transport systems;

c. to set fees sufficient to be self-supporting (which would include the costs of processing and conversion of solid wastes, less income from sales of reclaimed material);

d. to regulate the selling of all recovered materials on the basis of long-term, competitive bids (recognizing that in some cases private processers will pay for wastes to be recycled, and in other cases the public agency may have to pay them to take the wastes);

e. to regulate the processing of all toxic and special wastes so as to recover as much reusable material as possible and also to minimize the toxicity of the residues, and then to dispose of such residues in specially approved sites under rigidly enforced conditions to protect public health;

f. to require that all independent management of wastes (i.e., all wastes not entering the regional management system) meet standards established to protect public health and the environment;

g. to set standards for the manner in which waste materials are to be delivered to the processing/transfer stations after collection from homes, businesses and factories;

h. to encourage and support research and demonstration programs designed to process and recover resources from waste materials in the most efficient manner and at the lowest cost consistent with standards of environmental protection and resource conservation.

Regional management of solid wastes can be implemented by a governmental entity taking any of the following forms:

a. A multi-purpose, limited function, regional government could be created for the Bay Area and given, as one of its assignments, responsibility for carrying out the wastes management plan.

b. A single-purpose regional agency (such as the Bay Area Sewer Service Agency) could be created by the California Legislature.

c. A special wastes management and refuse disposal district encompassing Bay Area counties could be created pursuant to State laws governing either municipal utility or sanitary districts.

d. A regional agency could be established by existing public bodies pursuant to the State Joint Exercise of Powers Act.

Each of these alternatives has its own advantages and disadvantages and what is likely to develop in the future is difficult to predict. Each of these possibilities and several others were reviewed by the Action Committee in their search for an intergovernmental structure to manage the Demonstration.

## C. THE BAY DELTA RESOURCE RECOVERY DEMONSTRATION PROJECT

### 1. Objectives

A major objective of the Demonstration is to test the feasibility of a regional solid waste management system that would simultaneously recover resources from urban wastes and provide for land reclamation in the Sacramento-San Joaquin Delta. Specific project objectives are:

a. to demonstrate regional cooperation in conducting a solid waste demonstration project;

b. to demonstrate the technical and economic feasibility of recovery of resources from solid wastes;

c. to determine the engineering feasibility of levee reinforcement with composted urban refuse;

d. to demonstrate the agricultural worth of new soil built from composted refuse;

e. to determine the environmental effects, especially on air and water, of placing compost on a Delta island.

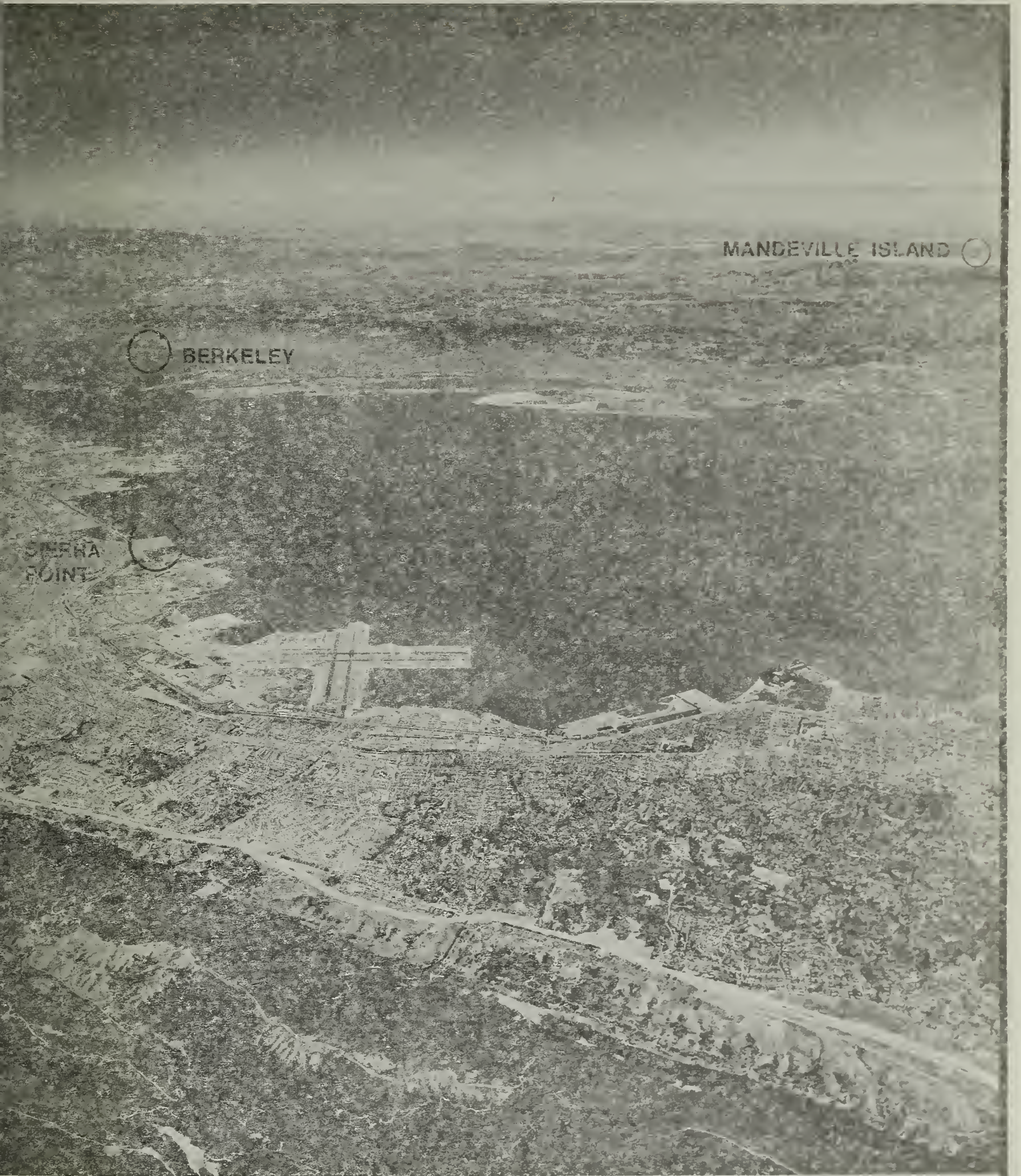
2. Operational Description

The Demonstration would be conducted over a two-year period, processing municipal refuse and sewage sludge in Berkeley and San Francisco.

In Berkeley, 200 tons per day of municipal refuse would be delivered to a transfer station for shredding, air classification and magnetic separation of ferrous metals. The light organic fraction would then be transported to a composting site located at the Berkeley landfill. Partially dewatered, digested sewage sludge from the East Bay Municipal Utility District would be mixed with the refuse in a windrow composting operation.

In San Francisco, residential refuse delivered to the existing transfer station would be shredded and air classified for recovery of metals and possibly glass; 150 tons per day of the light organic fraction of this refuse would be delivered to a composting site on land owned by the Sanitary Fill Company at Sierra Point in South San Francisco. Digested sewage sludge would be delivered to the composting plant from San Francisco's Southeast Sewage Treatment plant.

At each site, composting would be accomplished in long windrows or piles which are turned, aerated and moistened every few days to maintain aerobic (presence of oxygen) conditions. Composting would occur for approximately 21 days. The material would then be screened to remove plastic film and oversize particles.



Aerial view of the Bay-Delta Area
with Sierra Point, Berkeley, and
Mandeville Island indicated.

Pacific Resources, Inc.

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# Bay Delta Resource Recovery Demonstration Project

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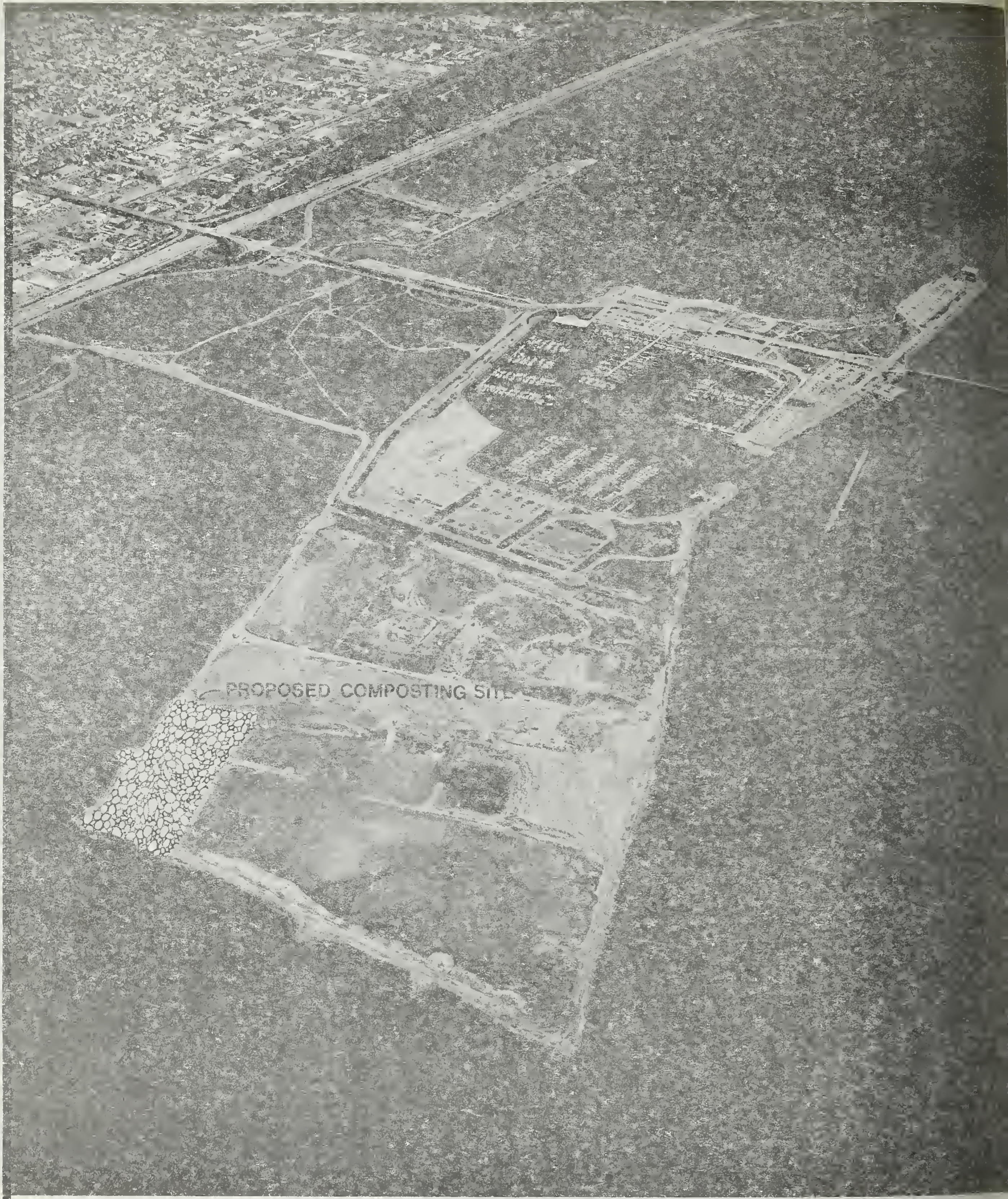

The Berkeley waterfront in 1971
with proposed composting site in foreground.

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# Bay Delta Resource Recovery Demonstration Project

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The Berkeley composting site - Albany Hill and Berkeley hills in background.

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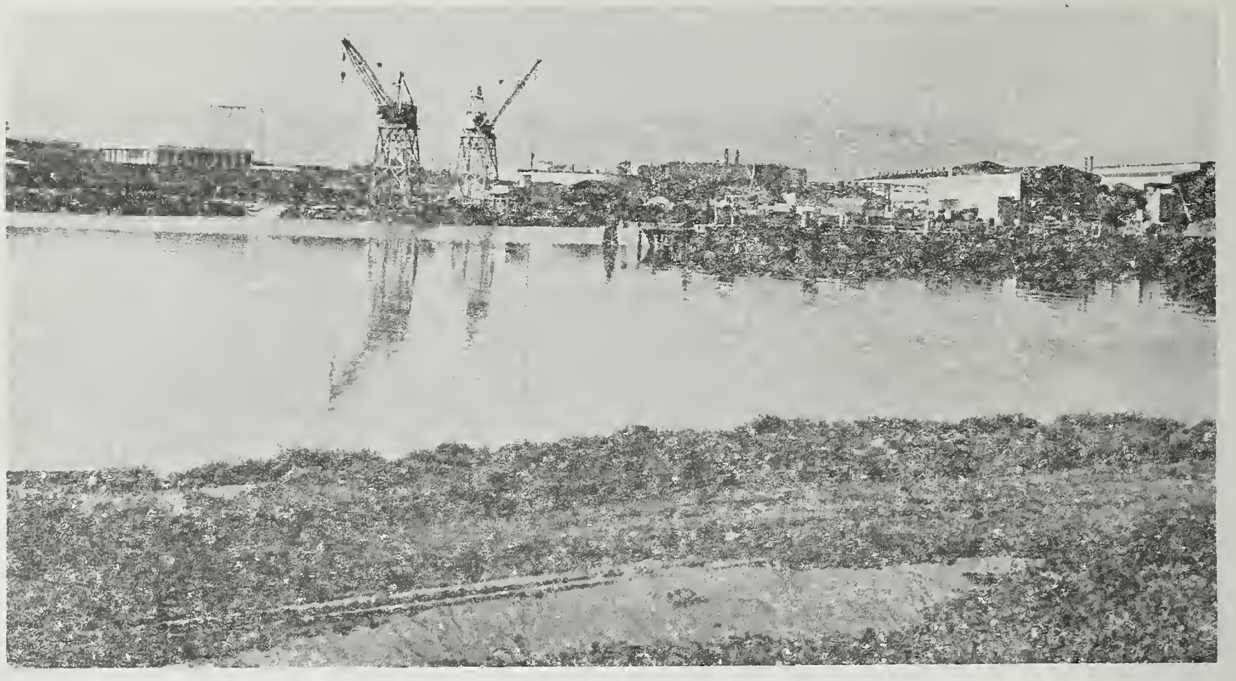
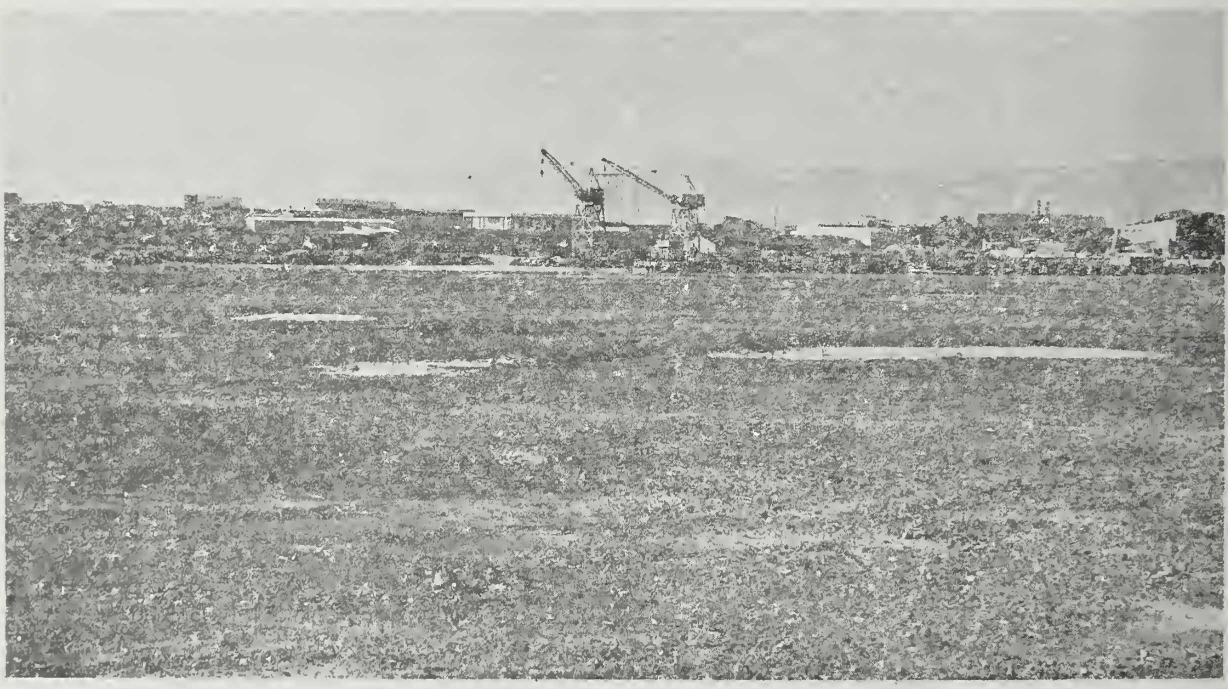
Bay Delta Resource Recovery Demonstration Project eip



View of waterway adjacent to Sierra Point.



The Sierra Point composting site.

About 100 tons of compost per day would be produced at each site for a total of 1,000 tons per week.

At each site, the compost would be loaded onto a barge docked in the adjacent waterway and shipped at weekly intervals to Mandeville Island in the Sacramento-San Joaquin Delta. The barges would be unloaded by a crane and compost would be placed behind an 1,800 foot stretch of levee in a berm extending up to 500 feet inland. This berm would be built up slowly over a two-year period to prevent excessive compression of the peat resulting from high loading rates that might weaken the levee. Monitoring of air quality, water quality, soil stability, agricultural productivity and biotic effects would be conducted to determine if large scale application of compost could be accomplished without environmental impairment to the Delta. Knowledge would also be gained about the extent of composting required, materials handling techniques and levee reinforcement procedures that could be applied to a full-scale operation.

### 3. Governmental Structure

The Demonstration project would be managed by an intergovernmental structure representing jurisdictions of the Bay Delta area.

For the purposes of the Demonstration, only a few of the functions of a regional solid waste management entity described in Section B need be served by the selected intergovernmental structure. These include:

a. the ability to manage the Demonstration project;

b. the ability to solicit and accept funding from state and federal sources;

c. the ability to fairly allocate the regional share of costs over local jurisdictions.

Several intergovernmental structures emerge as possible forms to manage the Bay Delta Resource Recovery Demonstration Project. The first involves the establishment of a Joint Exercise of Powers Agency consisting of all the counties of the Bay Delta region. The directors of the Agency could be elected officials of the constituent units, or they could be persons chosen by these units of government, either laymen or local officials such as public works directors. The second possibility is that Association of Bay Area Governments (ABAG) expand its traditional role of advisory planning to assume stewardship of the Demonstration project. The third is that a Joint Exercise of Powers Agency be formed among Bay Delta counties which would contract with ABAG for administrative services. And finally, a memorandum of agreement between ABAG and the Sacramento and San Joaquin Councils of Government could be formed.

Each of these alternatives would satisfy the requirements of the Demonstration and is suitable for transformation into the solid waste management arm of a possible future regional organization.

As of the date of this report the Action Committee has reconstituted itself as a Joint Powers Agency to pursue funding for the Demonstration. However, this Agency is only an interim agreement until an agency to manage the Demonstration can be established. The formation of this latter agency will require continued efforts by the new Joint Powers Agency in the months ahead.

## 4. Economic Analysis and Proposed Funding

The estimated cost of conducting the Demonstration is $6.9 million as shown in the table on the following page:

| | (A)<br>Capital<br>Costs | (B)<br>Annual<br>Operating<br>Costs | (C)=(A)+2(B)<br>Total Cost |
|---|---|---|---|
| Processing/Transfer Station | 253,000 | 162,000 | 577,000 |
| Composting | 2,250,000 | 692,000 | 3,634,000 |
| Barge transport | 500,000 | 545,000 | 1,590,000 |
| Compost placement | 110,000 | 200,000 | 510,000 |
| Monitoring | 54,000 | 170,000 | 394,000 |
| Project supervision | | 50,000 | 100,000 |
| Other | 25,000 | 25,000 | 75,000 |
| Total | $3,192,000 | $1,844,000 | $6,880,000 |

As the benefits of the Demonstration accrue to regional, state and federal interests, it is proposed that funding be divided among these levels of government. The recommended percentage cost allocation is 10% regional, 40% state and 50% federal. (The rationale for this allocation is contained in Section IIIC.) It is recommended that the regional share be divided among all counties of the Bay Area on a pro rata population basis.

## D. CONCEPT OF A FULL-SCALE SYSTEM

### 1. Transfer Stations and Resource Recovery

As public sentiment for resource recovery continues to mount, and as close in landfill sites around the perimeter of San Francisco Bay become unavailable for further dumping operations, more and more communities will need to develop transfer stations regardless of the ultimate disposition of the waste. The transfer station owned by the San Francisco scavenger companies is a prototype of this operation. Once the need for a transfer station is established, it is increasingly apparent that the recovery of metals and glass through shredding and mechanical separation is technically feasible and probably economically viable, given a sufficient quantity of refuse. A multitude of resource recovery systems adapted from mining and lumbering industries are currently under development or installation across the United States. Most of these systems are based on the principal of particle size reduction followed by ballistic separation of the light organic fraction of solid wastes from the heavy, largely inert fraction. Over the next decade it is likely that such systems will be installed within the Bay Area. The SPUR report projected a need for 16 such transfer stations although the exact number and location of these stations will depend upon many factors. The extent of resource recovery at these stations will depend more upon the market price for reclaimed materials than on the availability of the technology needed to produce them.

### 2. Composting

Composting technology has been extensively developed in both Europe and the United States. Many composting processes are available, ranging from enclosed digesters with automatic control of such factors as moisture and aeration, to windrow systems where organic wastes are piled in long rows and turned every few days by specially designed vehicles. An enclosed composting system will soon be demonstrated by the Delaware Reclamation Project in Wilmington, Delaware under an EPA grant. Enclosed systems may be impractical for the composting of 5-10,000 tons per day of organic wastes in the Bay Area. The largest systems which have been designed to date have a capacity of only 200-300 tons per day. Windrow composting was selected in the preliminary design for the Demonstration because it appears more feasible to scale up. The only limit to its capacity is the availability of land--a total of perhaps 300 acres would be needed to compost all the Bay Area's wastes. This could be accomplished on completed landfills or on marginal lands around the Bay Area. A key aim of the Demonstration is to determine the optimal composting process that would apply on a large scale.

Over the last 20 years American composting operations have largely been unsuccessful, not due to technological problems, but because of a lack of market for sale of the humus product. In contrast, the Bay-Delta plan has an automatic function for humus in the Delta. Its use would serve the general interest and would be supported by public payment if its value for levee stabilization and topsoil building can be demonstrated.

### 3. Transportation

Finished compost would be delivered to most islands in the Delta by barge. One thousand- and two thousand-ton capacity barges can be designed with special screw conveyors and elevators for efficient unloading at the destination island. The unloading operation could occur at a single point on an island or, conceivably, the barge could unload at various points around the island as sections of the levee berm were completed. A few islands in the Delta can also be reached by rail. The feasibility of rail haul would depend on locating the composting site near a rail line.

### 4. Levee Reinforcement

Studies conducted by Duncan and Seed[1] on the feasibility of stabilizing Delta levees with a compost berm indicate that both beneficial and detrimental effects could result. While it would provide increased stability on the landside slope of the levee, non-uniform settlement of the underlying peat could result in longitudinal cracking of the levee over a period of years. Settlement would also result in lowering the elevation of the levee tops causing some loss of "freeboard." Considering the need to eventually strengthen the levees by some means, the report concludes that constructing a berm adjacent to the levees appears to be the best method of strengthening them, and that compost has engineering properties suited for this task. The conclusions reached are based on a preliminary study and only carefully conducted field studies can provide definitive information on the suitability of compost as a levee strengthening material.

---

[1] See Volume 3, Technical Report on Levee Stabilization and Composting.

## 5. Impact on Solid Waste Disposal

Full-scale operation of the plan could have a major impact on the quantity of solid wastes requiring disposal in the Bay Area. Solid wastes reaching disposal sites can be classified as follows:

| Category | % of Total Disposal |
|---|---|
| Residential | 35.7% |
| Commercial and public (including sewage sludge) | 42.9 |
| Construction and demolition | 14.3 |
| Industrial | 7.1 |
|  | 100.0% |

If newspapers are sorted for recycling and residential and commercial wastes are processed for recovery of metals and glass and composting of the organic remainder, the estimated disposition of all wastes is as follows:

| Item | % of Total Wastes |
|---|---|
| Compost (35% moisture) | 40.0% |
| Recovered metals, glass and paper | 10.0 |
| Carbon dioxide and water lost | 20.0 |
| Residue for disposal | 30.0 |
|  | 100.0% |

It is likely that not all commercial wastes are suitable for composting which would increase the amount of wastes requiring disposal. On the other hand, if residuals (plastics, rubber, leather and other combustibles) can be used for energy production or if construction debris can find a useful application, less wastes would require disposal. Thus, as a first approximation it appears that between 50% and 70% of the total solid waste disposal load of the Bay Area could be managed through resource recovery and composting for land reclamation. Because sewage sludge is generated relative to organic refuse in a proportion optimal for proper composting, all sewage sludge could be recycled in the process.

### 6. Impact on Levee Stabilization

Each year the repair of breeched levees becomes more problematical. Unless a permanent levee protection plan is soon developed, other islands may flood as have Frank's Tract, Big Break and the west end of Sherman Island, with irreparable loss of agricultural land and human settlements.

The quantity of solid wastes available in the Bay Area for conversion into levee reinforcing material appears to be sufficient to treat unstable levees at a moderate rate. According to the most recent figures from the State Department of Health, 5.7 million tons of solid wastes are disposed of in the Bay Delta Area annually. Of this total, it is estimated that 2.25 million tons of compost could be produced per year, enough to reinforce 5.5 miles of levee. This quantity of compost will increase, however, since annual solid waste generation is likely to keep growing and since agricultural wastes, which would roughly double the available supply of organic materials for composting may require disposal in the future.

About 200 miles of levee have been identified by the Corps of Engineers as being in some state of deterioration. At a rate of 5.5 miles of levee per year, about 36 years would be required to stabilize these levees. It would of course be prudent to begin with levees which are in the worst condition, and then proceed to those which are in less immediate need of care.

### 7. Environmental Effects

The Bay Delta plan offers an opportunity to alleviate adverse environmental effects resulting from both solid waste disposal operations and the subsidence of land in the Sacramento-San Joaquin Delta.

Solid wastes, including sewage sludge are in most cases unprocessed and dumped in landfills around the perimeter of the Bay. This results in a loss of recoverable resources and often a removal of wildlife habitat and impairment to the quality of waters surrounding the disposal site. The Bay Delta plan would at least cut in half the volume of wastes requiring conventional landfill.

In the Delta, the plan would offer an opportunity to strengthen weak sections of the levee, provide additional top soil for agriculture, and possibly reduce the amount of airborne peat dust. By preserving Delta levees, vast areas of highly valuable agricultural land would be protected, as well as the quality of Delta waters by avoiding the serious salt water intrusion from San Francisco which occurs when levees are breached.

The potential exists for environmental impairment, however. Thus a major reason for conducting the Demonstration is to monitor air quality, water quality, levee performance, agricultural productivity and biotic impacts.

In an environmental evaluation conducted for the Demonstration, several potential problems were identified. The most significant was the possible leaching of contaminants into Delta waters resulting in adverse impacts on wildlife and water quality. Although it may develop that some restrictions need to be placed on the kinds of refuse and sludge used, no findings have been uncovered indicating that unacceptable environmental impacts would occur. The ultimate environmental safeguard of the plan is that adverse environmental effects can be detected in the pilot-scale Demonstration before full-scale implementation ever occurs.

## 8. Projected Costs

A basic assumption underlying the Bay-Delta plan is that in the future, municipalities will be responsible for the conversion of solid wastes into useful and marketable products and for the disposal of the remaining residue. A higher level jursidiction, representing the broader public interest at the state and/or federal level would be responsible for the transportation and placement of compost in the Delta. Such an approach will be needed to achieve a fair division of economic responsibility among the parties that would benefit from this double-goaled program.

The local share of full-scale operation of the Bay Delta plan could range from $9-$12 per ton of refuse processed. This is considerably higher than the cost of local landfill operations which cost about $2-$4 per ton. However, estimates for the cost of regional sanitary landfills (requiring baling and long transportation hauls) have been offered from $7-$15 per ton. Thus, as close-in landfill sites become unavailable and as disposal operations are upgraded to true sanitary landfill requirements, it appears that the Bay-Delta plan could be an economically viable alternative to municipalities seeking new solutions to the solid waste management problem.

The Bay-Delta plan also involves the expense of transporting compost to the Delta and placement of the material behind levees. Preliminary estimates indicate that this could cost on the order of $7 per ton of compost applied. Assuming that 75 tons of compost would be needed per foot of levee treated, this cost is estimated to be $2.8 million per mile of levee treated. Using all of the organic wastes of the Bay Delta Area would result in the buttressing of at least 5.5 miles of levee annually at a cost of about $15 million.

These costs are estimated conservatively and they are based upon many assumptions whose validity cannot be determined until more conclusive results are obtained from the Demonstration. Even if these costs prevail, less expensive alternative proposals for buttressing levees with dredger spoils may prove infeasible for a variety of reasons. Dredger spoils are almost twice as dense as compacted compost and their weight may cause even greater cracking and settlement of levees than predicted for compost. Also, dredger spoils may not be obtainable from adjacent river channels due to permit restrictions. Barge haul from remote sources would increase costs considerably and may offer only random availability. In contrast, organic solid wastes are generated on a constant, predictable basis and would offer a permanent, dependable supply.

## 9. Political Feasibility

The major test of the viability of the Bay-Delta plan will probably not reside in its economic, environmental or technical feasibility, but in its political feasibility. Nearly unprecedented cooperation between local governments, Delta landowners, the refuse removal industry, and state and federal agencies must be achieved in order to make a sufficient quantity of compost available for preservation of the Sacramento-San Joaquin Delta. This political cooperation will ultimately be the essential ingredient required to convert an exciting idea with tremendous potential into an operating reality.

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# SOLID WASTE MANAGEMENT IMPLEMENTATION PROJECT

## SAN FRANCISCO BAY AREA

## Volume I

Project Report

ABAG
ASSOCIATION
OF BAY AREA
GOVERNMENTS

# BAY AREA
# SOLID WASTE MANAGEMENT
# IMPLEMENTATION PROJECT

## VOLUME I

PROJECT REPORT

RECEIVED
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A Report Prepared for the Action Committee for
the Bay Delta Resource Recovery Demonstration
and the Association of Bay Area Governments

December 1973 by

ENVIRONMENTAL IMPACT
PLANNING CORPORATION
SAN FRANCISCO, CALIF.
eip

In association with Frank Stead

ABAG
ASSOCIATION
OF BAY AREA
GOVERNMENTS

The preparation of this report was financed in part through a
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16. Abstracts This document is Volume I of a three-part report to ABAG. This report documents the planning conducted for the Bay Delta Resource Recovery Demonstration project. This proposed project would demonstrate recovery of resources from urban wastes and the use of composted refuse for island reclamation in the Sacramento-San Joaquin Delta. The report presents original research on the use of compost as a levee strengthening material and documents the planning for an intergovernmental structure to manage the demonstration, and serve as a first step towards eventual regional management of solid wastes. The report is published in three volumes, as follows:

Vol. I: Project Report
Vol. II: Environmental Evaluation for the Bay Delta Resource Recovery Demonstration Project
Vol. III: Technical Report on Levee Stabilization and Composting

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December 14, 1973

Mr. Revan A. F. Tranter
Executive Director
Association of Bay Area Governments
Claremont Hotel
Berkeley, California 94705

Dear Mr. Tranter:

In the fall of 1972 a group of local agencies in the San Francisco Bay Area joined together in an attempt to initiate a Demonstration project to test the feasibility of using composted organic solid wastes in the low-lying islands of the Sacramento-San Joaquin Delta for levee stabilization, land building and agricultural purposes. These local agencies, calling themselves the Bay Delta Resource Recovery Action Committee, also sought to develop the intergovernmental institution necessary to manage this Demonstration project and perhaps to become the regional agency charged with solid waste management. This report documents the efforts of these local entities, acting voluntarily, to attempt to improve the technical and governmental mechanisms operating in the field of solid waste management today.

The report is presented in three volumes. Volume 1 describes the preliminary system design for the Demonstration project and looks at the concept of Bay-area wide implementation of the plan. It also details the possible institutional mechanisms necessary to implement the plan. Volume 2 is an environmental evaluation of the Demonstration project and is written in the format of an Environmental Impact Report. Volume 3 contains two technical reports upon which the preliminary system design was based. Part A is a study of the structural characteristics of compost and an evaluation of the feasibility of using compost as a levee strengthening material. This report, prepared by Drs. Duncan and Seed of the Engineering Department of the University of California, Berkeley, represents original research on this subject. Part B documents the preliminary compost experiment conducted by Dr. Samuel Hart at Davis, California, and includes recommended composting specifications for the Demonstration.

The consultants wish to thank the members of the Action Committee and its chairman, Councilman Fred Maggiora, for making this report possible. We would also like to thank the U.S. Army Corps of Engineers (San Francisco and Sacramento Districts), the

California Department of Water Resources, the Central Valley Regional Water Quality Control Board, and the California Water Resources Control Board for their valuable contributions. Further, we would like to thank the Sierra Club, the League of Women Voters and the San Francisco Planning and Urban Renewal Association, as well as the many public and private organizations and individuals who participated in this study.

Yours very truly,

Hans A. Feibusch, P.E. and Frank M. Stead

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# FOREWORD

For over two hundred years this country has operated under a "cowboy economy"--throwing its natural resources away after one-time use. Now, as we consume more and more of these resources we are beginning to see the bottom of the barrel, not only for metals, minerals and wood products, but for fossil fuels as well. So we now find ourselves in danger of running out of both materials of manufacture and construction and sources of fuel. Our response has been to look at solid wastes as a new kind of ore and a new kind of fuel, and this is unquestionably a great step forward.

But at the same time we have been steadily "consuming" our most important resource of all--topsoil--the very basis of the support system for plant and animal life without which man cannot exist. We ship huge crops of vegetable foods and plant-fed animals to cities. Most of these organic materials taken from the soil are never put back. In addition, we allow wind and water to erode away topsoil, we cover it over with highways and cities, and we strip it away to more easily get at large deposits of coal and other mineral resources.

The natural replacement of lost topsoil is amazingly slow. Nature takes from 500 to 1,000 years to make one inch of topsoil. Our deepest concern, therefore, should be to halt, or at least slow down, this steady depletion of the country's soil mantle.

In the Bay Area nearly ten million tons of solid wastes are generated each year. Bay Area wastes that are collected are hauled by truck for burial in soil-covered disposal sites. Some sites are well engineered and operated so as to prevent health hazards, nuisance, and water pollution, but many are not. At the same time, at the north end of San Francisco Bay, where the Sacramento and San Joaquin Rivers merge, a delta of numerous scattered islands of peat exists. The Delta islands were diked against water intrusion during the early part of the century and include 500,000 acres of intensively cultivated agricultural lands. However, the islands have been sinking at the rate of two to three inches per year and are now ten to fifteen feet below sea level. Many of the dikes are weak and subject to frequent rupture as occurred dramatically in June 1972, when Andrus and Brannan Islands were inundated. If this situation is allowed to continue, loss of most of these valuable agricultural lands is virtually assured.

Several years ago the San Francisco Planning and Urban Renewal Association (SPUR), after a two-year study, proposed a mutual solution to the solid waste and Delta land subsidence problems. A pilot-scale Demonstration project was recommended to test this proposal (The Bay Delta Resource Recovery Demonstration).

The Demonstration is dedicated to the long range goal of returning to the land the materials from which topsoil is made--namely, the humus produced by bacterial decomposition of plant and animal residues. It would convert the organic portion of municipal refuse into a compost closely resembling natural peat soil. Compared to the conversion of solid wastes into combustible fuel supplies by incineration or pyrolysis, composting is a form of energy recovery occurring in the biological realm. The energy of organic materials in compost supports microbial action which efficiently stores and releases nutrients in the soil.

The peat islands of the Sacramento-San Joaquin Delta were selected as the site for the Demonstration because they illustrate an extreme case of topsoil erosion--caused in this case by the combined effects of wind and auto-oxidation. The islands also afford an unprecedented opportunity to compare directly the fertility of manmade topsoil with highly fertile natural Delta peat.

Because the Delta islands are in imminent danger of extinction by flooding, the first placement of compost will be in the form of a wide berm to physically buttress the levees. Later phases envision application of compost to the entire floors of the islands.

The vast agricultural area of the Delta has the capacity to assimilate the entire output of organic materials from the San Francisco Bay Metropolitan Region on a perpetual basis. Thus, the Bay-Delta Demonstration may well be the harbinger of a truly revolutionary change. We can perhaps turn from a system which diminishes our natural resources and increases our mountains of waste to a system in which the most valuable resource of all--the land--is preserved in undiminished productivity forever.

# I. SUMMARY AND CONCLUSIONS

## A. INTRODUCTION

This project has as its base the 1971 Report of the San Francisco Planning and Urban Renewal Association entitled "A Solid Wastes Management System for the Bay Region." Commonly known as the Bay Delta Plan, that report called for regional management of solid wastes; a maximum recovery of resources from the solid wastes stream; and a proposal to use the organic portion of municipal refuse for island reclamation in the Sacramento-San Joaquin Delta.

A three-phase program toward regional solid waste management was recommended. In Phase I, the planning would occur for a pilot scale Demonstration to test the concept of separating wastes and transporting the composted organic portion to the Delta islands. An intergovernmental structure would be formed to secure funding for and to manage the Demonstration project. In Phase II the Demonstration would be conducted, and in Phase III the Bay Area could move into permanent, full-scale operation of a regional plan.

Two years of effort by a few dedicated public officials and private citizens resulted in the formation of the Action Committee for the Bay Delta Resource Recovery Demonstration under the sponsorship of the Association of Bay Area Governments (ABAG) to carry out Phase I. The Action Committee developed into a diverse and dynamic coalition of elected officials, public administrators, engineers and concerned citizens representing large and small cities, rural and metropolitan areas, utilities and the private sector of the solid wastes industry.

Although such a broad range of interest often results in cautious progress, it is certainly the most deliberate and responsible way to proceed in planning for any regional solid waste management program.

The planning study focused on three basic areas. First, intergovernmental arrangements were explored to manage the Demonstration project on behalf of the political jurisdictions of the Bay Area. It was thought that these arrangements might serve as a first step to regional cooperation and eventual regional management of solid waste. Second, a preliminary system design was developed for the Demonstration including selection of participants, design of a monitoring program, economic analysis and an environmental evaluation. Finally, the concept of full-scale implementation of the plan in the Bay Area was investigated in terms of its costs and technical, environmental and political feasibility.

The results of this study suggest a number of areas of concern. The formation of an intergovernmental agency to manage the Demonstration has been slow and continued efforts will be required to achieve a final welding of this institution. Feasibility studies indicate that placement of compost behind Delta levees may cause cracking of the levees, and leachates from the compost may have adverse effects on water quality and wildlife in the Delta sloughs. Also, full-scale implementation of the project is likely to result in a high per mile cost of buttressed levee. However, no obstacles have been identified which seem to be insurmountable and it is clear that a pilot scale Demonstration project offers the best opportunity to answer the questions which have been raised. In view of the exciting potential of this program for solving a major portion of the solid waste disposal problem and for contributing to the stabilization of Delta levees, the pilot scale Demonstration should proceed as rapidly as possible in order to test the validity of this plan.

## B. REGIONAL SOLID WASTE MANAGEMENT

According to the SPUR report, an essential element of the plan includes the management of solid wastes on a regioal basis. Only on a region-wide basis can a resource recovery plants of economical size be developed and efficient transportation routes be established. Perhaps most importantly, only on a regional basis can the intergovernmental agreements be developed which are necessary for large scale land reclamation in the Delta.

A regional waste management plan should be carried out in accordance with the following principles:

a. A new governmental entity is needed to carry out a region-wide wastes management program for the Bay Area.

b. To the greatest extent feasible, private enterprise should be encouraged to undertake all aspects of solid wastes management--collection, resource recovery and disposal.

c. Inventive proposals to carry out aspects of the regional plan should be encouraged, and should be evaluated on the basis of their conformity to the regional plan.

An intergovernmental entity is needed for regional management of solid wastes for the following reasons:

a. to manage demonstration projects that would have region-wide application;

b. to solicit and accept funding from state, federal and other sources;

c. to allocate costs fairly among local jurisdictions;

d. to plan comprehensively, including transportation and land use as well as waste processing and disposal;

e. to facilitate inter-county transfers of waste materials;

f. to make a systems approach to resource recovery more feasible;

g. and finally, to eliminate the need for direct federal and state controls.

An ultimate regional solid wastes management entity, regardless of its form, should have the following powers and duties:

a. to arrange for the processing of the region's solid wastes;

b. to arrange for the building or leasing of a system of regional processing/transfer stations and transport systems;

c. to set fees sufficient to be self-supporting (which would include the costs of processing and conversion of solid wastes, less income from sales of reclaimed material);

d. to regulate the selling of all recovered materials on the basis of long-term, competitive bids (recognizing that in some cases private processers will pay for wastes to be recycled, and in other cases the public agency may have to pay them to take the wastes);

e. to regulate the processing of all toxic and special wastes so as to recover as much reusable material as possible and also to minimize the toxicity of the residues, and then to dispose of such residues in specially approved sites under rigidly enforced conditions to protect public health;

f. to require that all independent management of wastes (i.e., all wastes not entering the regional management system) meet standards established to protect public health and the environment;

g. to set standards for the manner in which waste materials are to be delivered to the processing/transfer stations after collection from homes, businesses and factories;

h. to encourage and support research and demonstration programs designed to process and recover resources from waste materials in the most efficient manner and at the lowest cost consistent with standards of environmental protection and resource conservation.

Regional management of solid wastes can be implemented by a governmental entity taking any of the following forms:

a. A multi-purpose, limited function, regional government could be created for the Bay Area and given, as one of its assignments, responsibility for carrying out the wastes management plan.

b. A single-purpose regional agency (such as the Bay Area Sewer Service Agency) could be created by the California Legislature.

c. A special wastes management and refuse disposal district encompassing Bay Area counties could be created pursuant to State laws governing either municipal utility or sanitary districts.

d. A regional agency could be established by existing public bodies pursuant to the State Joint Exercise of Powers Act.

Each of these alternatives has its own advantages and disadvantages and what is likely to develop in the future is difficult to predict. Each of these possibilities and several others were reviewed by the Action Committee in their search for an intergovernmental structure to manage the Demonstration.

## C. THE BAY DELTA RESOURCE RECOVERY DEMONSTRATION PROJECT

### 1. Objectives

A major objective of the Demonstration is to test the feasibility of a regional solid waste management system that would simultaneously recover resources from urban wastes and provide for land reclamation in the Sacramento-San Joaquin Delta. Specific project objectives are:

a. to demonstrate regional cooperation in conducting a solid waste demonstration project;

b. to demonstrate the technical and economic feasibility of recovery of resources from solid wastes;

c. to determine the engineering feasibility of levee reinforcement with composted urban refuse;

d. to demonstrate the agricultural worth of new soil built from composted refuse;

e. to determine the environmental effects, especially on air and water, of placing compost on a Delta island.

## 2. Operational Description

The Demonstration would be conducted over a two-year period, processing municipal refuse and sewage sludge in Berkeley and San Francisco.

In Berkeley, 200 tons per day of municipal refuse would be delivered to a transfer station for shredding, air classification and magnetic separation of ferrous metals. The light organic fraction would then be transported to a composting site located at the Berkeley landfill. Partially dewatered, digested sewage sludge from the East Bay Municipal Utility District would be mixed with the refuse in a windrow composting operation.

In San Francisco, residential refuse delivered to the existing transfer station would be shredded and air classified for recovery of metals and possibly glass; 150 tons per day of the light organic fraction of this refuse would be delivered to a composting site on land owned by the Sanitary Fill Company at Sierra Point in South San Francisco. Digested sewage sludge would be delivered to the composting plant from San Francisco's Southeast Sewage Treatment plant.

At each site, composting would be accomplished in long windrows or piles which are turned, aerated and moistened every few days to maintain aerobic (presence of oxygen) conditions. Composting would occur for approximately 21 days. The material would then be screened to remove plastic film and oversize particles.

ial view of the Bay-Delta Area
h Sierra Point, Berkeley, and
deville Island indicated.

Pacific Resources, Inc.

**ABAG** ASSOCIATION OF BAY AREA GOVERNMENTS

**Bay Delta Resource Recovery Demonstration Project**

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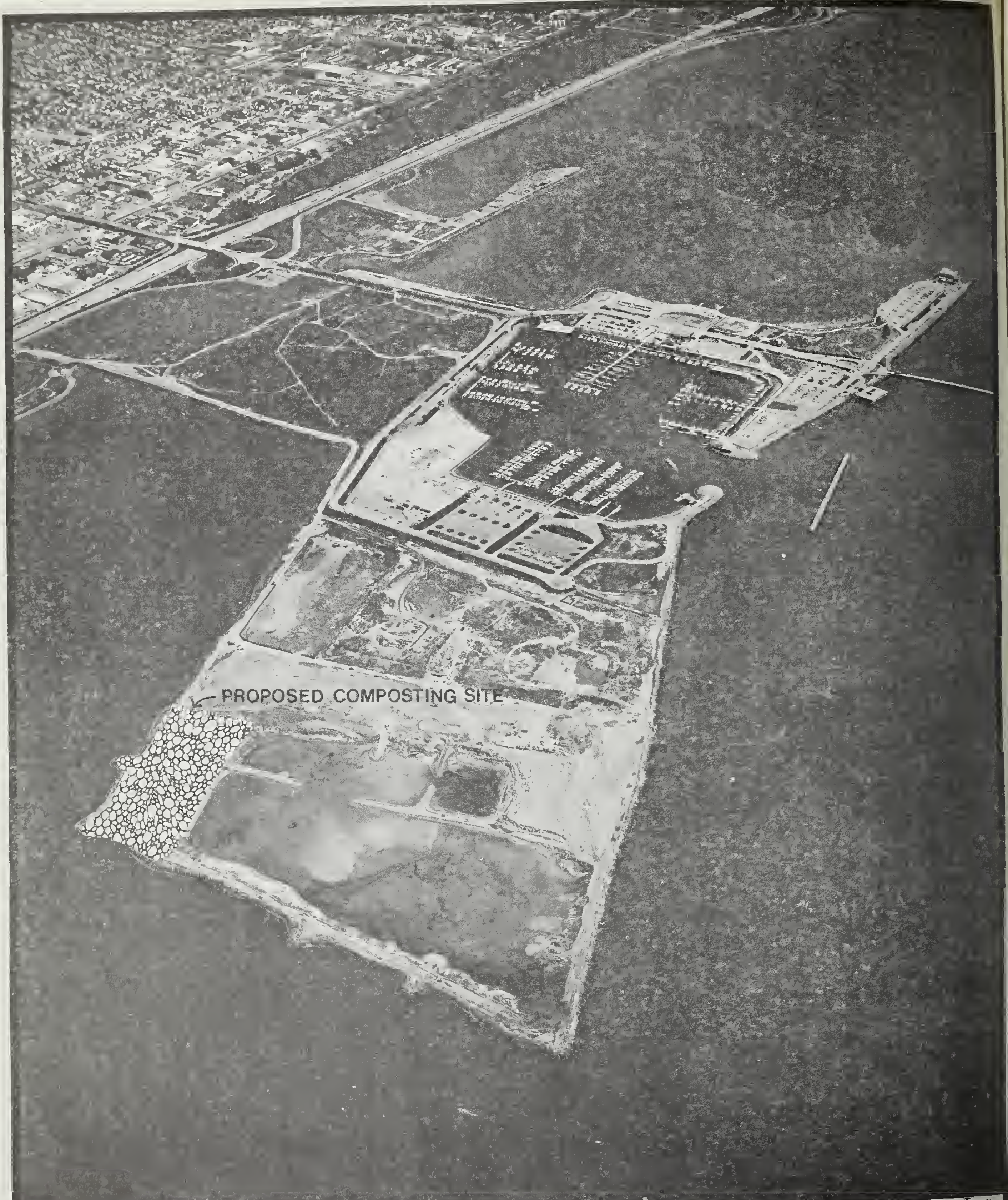

The Berkeley waterfront in 1971
with proposed composting site in foreground.

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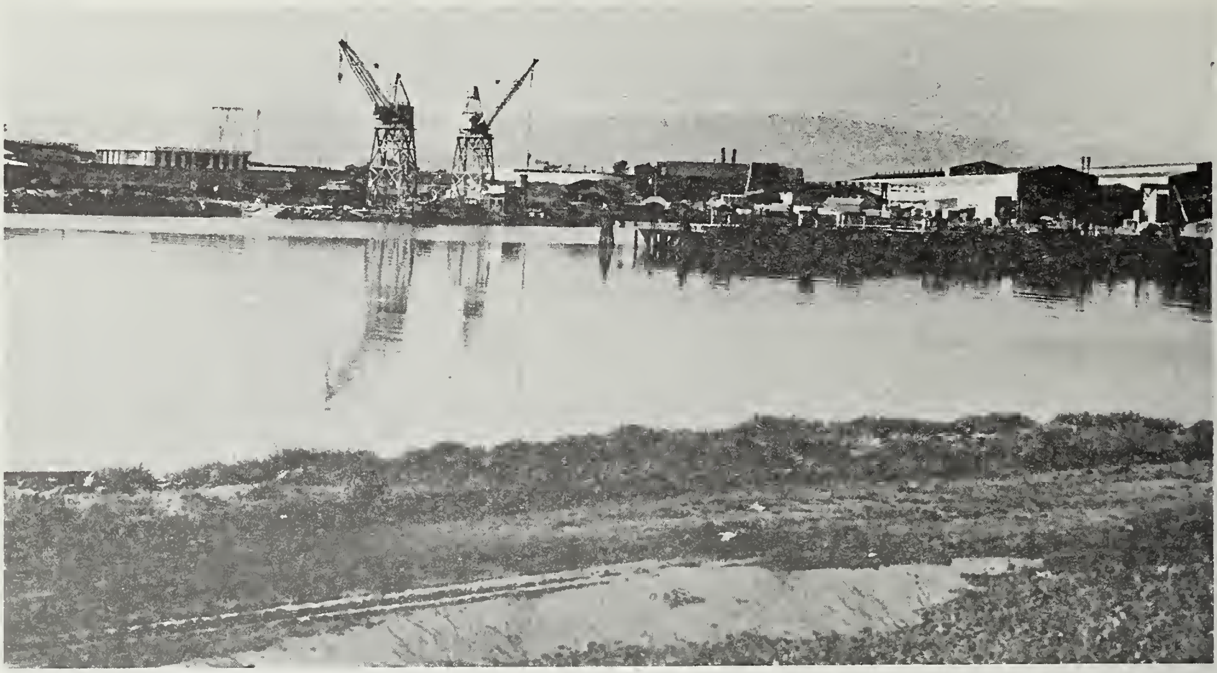
The Berkeley composting site - Albany Hill and Berkeley hills in background.



View of waterway adjacent to Sierra Point.

The Sierra Point composting site.

About 100 tons of compost per day would be produced at each site for a total of 1,000 tons per week.

At each site, the compost would be loaded onto a barge docked in the adjacent waterway and shipped at weekly intervals to Mandeville Island in the Sacramento-San Joaquin Delta. The barges would be unloaded by a crane and compost would be placed behind an 1,800 foot stretch of levee in a berm extending up to 500 feet inland. This berm would be built up slowly over a two-year period to prevent excessive compression of the peat resulting from high loading rates that might weaken the levee. Monitoring of air quality, water quality, soil stability, agricultural productivity and biotic effects would be conducted to determine if large scale application of compost could be accomplished without environmental impairment to the Delta. Knowledge would also be gained about the extent of composting required, materials handling techniques and levee reinforcement procedures that could be applied to a full-scale operation.

### 3. Governmental Structure

The Demonstration project would be managed by an intergovernmental structure representing jurisdictions of the Bay Delta area.

For the purposes of the Demonstration, only a few of the functions of a regional solid waste management entity described in Section B need be served by the selected intergovernmental structure. These include:

a. the ability to manage the Demonstration project;

b. the ability to solicit and accept funding from state and federal sources;

c. the ability to fairly allocate the regional share of costs over local jurisdictions.

Several intergovernmental structures emerge as possible forms to manage the Bay Delta Resource Recovery Demonstration Project. The first involves the establishment of a Joint Exercise of Powers Agency consisting of all the counties of the Bay Delta region. The directors of the Agency could be elected officials of the constituent units, or they could be persons chosen by these units of government, either laymen or local officials such as public works directors. The second possibility is that Association of Bay Area Governments (ABAG) expand its traditional role of advisory planning to assume stewardship of the Demonstration project. The third is that a Joint Exercise of Powers Agency be formed among Bay Delta counties which would contract with ABAG for administrative services. And finally, a memorandum of agreement between ABAG and the Sacramento and San Joaquin Councils of Government could be formed.

Each of these alternatives would satisfy the requirements of the Demonstration and is suitable for transformation into the solid waste management arm of a possible future regional organization.

As of the date of this report the Action Committee has reconstituted itself as a Joint Powers Agency to pursue funding for the Demonstration. However, this Agency is only an interim agreement until an agency to manage the Demonstration can be established. The formation of this latter agency will require continued efforts by the new Joint Powers Agency in the months ahead.

### 4. Economic Analysis and Proposed Funding

The estimated cost of conducting the Demonstration is $6.9 million as shown in the table on the following page:

| | (A)<br>Capital Costs | (B)<br>Annual Operating Costs | (C)=(A)+2(B)<br>Total Cost |
|---|---|---|---|
| Processing/Transfer Station | 253,000 | 162,000 | 577,000 |
| Composting | 2,250,000 | 692,000 | 3,634,000 |
| Barge transport | 500,000 | 545,000 | 1,590,000 |
| Compost placement | 110,000 | 200,000 | 510,000 |
| Monitoring | 54,000 | 170,000 | 394,000 |
| Project supervision | | 50,000 | 100,000 |
| Other | 25,000 | 25,000 | 75,000 |
| Total | $3,192,000 | $1,844,000 | $6,880,000 |

As the benefits of the Demonstration accrue to regional, state and federal interests, it is proposed that funding be divided among these levels of government. The recommended percentage cost allocation is 10% regional, 40% state and 50% federal. (The rationale for this allocation is contained in Section IIIC.) It is recommended that the regional share be divided among all counties of the Bay Area on a pro rata population basis.

## D. CONCEPT OF A FULL-SCALE SYSTEM

### 1. Transfer Stations and Resource Recovery

As public sentiment for resource recovery continues to mount, and as close in landfill sites around the perimeter of San Francisco Bay become unavailable for further dumping operations, more and more communities will need to develop transfer stations regardless of the ultimate disposition of the waste. The transfer station owned by the San Francisco scavenger companies is a prototype of this operation. Once the need for a transfer station is established, it is increasingly apparent that the recovery of metals and glass through shredding and mechanical separation is technically feasible and probably economically viable, given a sufficient quantity of refuse. A multitude of resource recovery systems adapted from mining and lumbering industries are currently under development or installation across the United States. Most of these systems are based on the principal of particle size reduction followed by ballistic separation of the light organic fraction of solid wastes from the heavy, largely inert fraction. Over the next decade it is likely that such systems will be installed within the Bay Area. The SPUR report projected a need for 16 such transfer stations although the exact number and location of these stations will depend upon many factors. The extent of resource recovery at these stations will depend more upon the market price for reclaimed materials than on the availability of the technology needed to produce them.

### 2. Composting

Composting technology has been extensively developed in both Europe and the United States. Many composting processes are available, ranging from enclosed digesters with automatic control of such factors as moisture and aeration, to windrow systems where organic wastes are piled in long rows and turned every few days by specially designed vehicles. An enclosed composting system will soon be demonstrated by the Delaware Reclamation Project in Wilmington, Delaware under an EPA grant. Enclosed systems may be impractical for the composting of 5-10,000 tons per day of organic wastes in the Bay Area. The largest systems which have been designed to date have a capacity of only 200-300 tons per day. Windrow composting was selected in the preliminary design for the Demonstration because it appears more feasible to scale up. The only limit to its capacity is the availability of land--a total of perhaps 300 acres would be needed to compost all the Bay Area's wastes. This could be accomplished on completed landfills or on marginal lands around the Bay Area. A key aim of the Demonstration is to determine the optimal composting process that would apply on a large scale.

Over the last 20 years American composting operations have largely been unsuccessful, not due to technological problems, but because of a lack of market for sale of the humus product. In contrast, the Bay-Delta plan has an automatic function for humus in the Delta. Its use would serve the general interest and would be supported by public payment if its value for levee stabilization and topsoil building can be demonstrated.

### 3. Transportation

Finished compost would be delivered to most islands in the Delta by barge. One thousand- and two thousand-ton capacity barges can be designed with special screw conveyors and elevators for efficient unloading at the destination island. The unloading operation could occur at a single point on an island or, conceivably, the barge could unload at various points around the island as sections of the levee berm were completed. A few islands in the Delta can also be reached by rail. The feasibility of rail haul would depend on locating the composting site near a rail line.

### 4. Levee Reinforcement

Studies conducted by Duncan and Seed[1] on the feasibility of stabilizing Delta levees with a compost berm indicate that both beneficial and detrimental effects could result. While it would provide increased stability on the landside slope of the levee, non-uniform settlement of the underlying peat could result in longitudinal cracking of the levee over a period of years. Settlement would also result in lowering the elevation of the levee tops causing some loss of "freeboard." Considering the need to eventually strengthen the levees by some means, the report concludes that constructing a berm adjacent to the levees appears to be the best method of strengthening them, and that compost has engineering properties suited for this task. The conclusions reached are based on a preliminary study and only carefully conducted field studies can provide definitive information on the suitability of compost as a levee strengthening material.

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[1] See Volume 3, Technical Report on Levee Stabilization and Composting.

## 5. Impact on Solid Waste Disposal

Full-scale operation of the plan could have a major impact on the quantity of solid wastes requiring disposal in the Bay Area. Solid wastes reaching disposal sites can be classified as follows:

| Category | % of Total Disposal |
|---|---|
| Residential | 35.7% |
| Commercial and public (including sewage sludge) | 42.9 |
| Construction and demolition | 14.3 |
| Industrial | 7.1 |
| | 100.0% |

If newspapers are sorted for recycling and residential and commercial wastes are processed for recovery of metals and glass and composting of the organic remainder, the estimated disposition of all wastes is as follows:

| Item | % of Total Wastes |
|---|---|
| Compost (35% moisture) | 40.0% |
| Recovered metals, glass and paper | 10.0 |
| Carbon dioxide and water lost | 20.0 |
| Residue for disposal | 30.0 |
| | 100.0% |

It is likely that not all commercial wastes are suitable for composting which would increase the amount of wastes requiring disposal. On the other hand, if residuals (plastics, rubber, leather and other combustibles) can be used for energy production or if construction debris can find a useful application, less wastes would require disposal. Thus, as a first approximation it appears that between 50% and 70% of the total solid waste disposal load of the Bay Area could be managed through resource recovery and composting for land reclamation. Because sewage sludge is generated relative to organic refuse in a proportion optimal for proper composting, all sewage sludge could be recycled in the process.

### 6. Impact on Levee Stabilization

Each year the repair of breeched levees becomes more problematical. Unless a permanent levee protection plan is soon developed, other islands may flood as have Frank's Tract, Big Break and the west end of Sherman Island, with irreparable loss of agricultural land and human settlements.

The quantity of solid wastes available in the Bay Area for conversion into levee reinforcing material appears to be sufficient to treat unstable levees at a moderate rate. According to the most recent figures from the State Department of Health, 5.7 million tons of solid wastes are disposed of in the Bay Delta Area annually. Of this total, it is estimated that 2.25 million tons of compost could be produced per year, enough to reinforce 5.5 miles of levee. This quantity of compost will increase, however, since annual solid waste generation is likely to keep growing and since agricultural wastes, which would roughly double the available supply of organic materials for composting may require disposal in the future.

About 200 miles of levee have been identified by the Corps of Engineers as being in some state of deterioration. At a rate of 5.5 miles of levee per year, about 36 years would be required to stabilize these levees. It would of course be prudent to begin with levees which are in the worst condition, and then proceed to those which are in less immediate need of care.

### 7. Environmental Effects

The Bay Delta plan offers an opportunity to alleviate adverse environmental effects resulting from both solid waste disposal operations and the subsidence of land in the Sacramento-San Joaquin Delta.

Solid wastes, including sewage sludge are in most cases unprocessed and dumped in landfills around the perimeter of the Bay. This results in a loss of recoverable resources and often a removal of wildlife habitat and impairment to the quality of waters surrounding the disposal site. The Bay Delta plan would at least cut in half the volume of wastes requiring conventional landfill.

In the Delta, the plan would offer an opportunity to strengthen weak sections of the levee, provide additional top soil for agriculture, and possibly reduce the amount of airborne peat dust. By preserving Delta levees, vast areas of highly valuable agricultural land would be protected, as well as the quality of Delta waters by avoiding the serious salt water intrusion from San Francisco which occurs when levees are breached.

The potential exists for environmental impairment, however. Thus a major reason for conducting the Demonstration is to monitor air quality, water quality, levee performance, agricultural productivity and biotic impacts.

In an environmental evaluation conducted for the Demonstration, several potential problems were identified. The most significant was the possible leaching of contaminants into Delta waters resulting in adverse impacts on wildlife and water quality. Although it may develop that some restrictions need to be placed on the kinds of refuse and sludge used, no findings have been uncovered indicating that unacceptable environmental impacts would occur. The ultimate environmental safeguard of the plan is that adverse environmental effects can be detected in the pilot-scale Demonstration before full-scale implementation ever occurs.

## 8. Projected Costs

A basic assumption underlying the Bay-Delta plan is that in the future, municipalities will be responsible for the conversion of solid wastes into useful and marketable products and for the disposal of the remaining residue. A higher level jursidiction, representing the broader public interest at the state and/or federal level would be responsible for the transportation and placement of compost in the Delta. Such an approach will be needed to achieve a fair division of economic responsibility among the parties that would benefit from this double-goaled program.

The local share of full-scale operation of the Bay Delta plan could range from $9-$12 per ton of refuse processed. This is considerably higher than the cost of local landfill operations which cost about $2-$4 per ton. However, estimates for the cost of regional sanitary landfills (requiring baling and long transportation hauls) have been offered from $7-$15 per ton. Thus, as close-in landfill sites become unavailable and as disposal operations are upgraded to true sanitary landfill requirements, it appears that the Bay-Delta plan could be an economically viable alternative to municipalities seeking new solutions to the solid waste management problem.

The Bay-Delta plan also involves the expense of transporting compost to the Delta and placement of the material behind levees. Preliminary estimates indicate that this could cost on the order of $7 per ton of compost applied. Assuming that 75 tons of compost would be needed per foot of levee treated, this cost is estimated to be $2.8 million per mile of levee treated. Using all of the organic wastes of the Bay Delta Area would result in the buttressing of at least 5.5 miles of levee annually at a cost of about $15 million.

These costs are estimated conservatively and they are based upon many assumptions whose validity cannot be determined until more conclusive results are obtained from the Demonstration. Even if these costs prevail, less expensive alternative proposals for buttressing levees with dredger spoils may prove infeasible for a variety of reasons. Dredger spoils are almost twice as dense as compacted compost and their weight may cause even greater cracking and settlement of levees than predicted for compost. Also, dredger spoils may not be obtainable from adjacent river channels due to permit restrictions. Barge haul from remote sources would increase costs considerably and may offer only random availability. In contrast, organic solid wastes are generated on a constant, predictable basis and would offer a permanent, dependable supply.

## 9. Political Feasibility

The major test of the viability of the Bay-Delta plan will probably not reside in its economic, environmental or technical feasibility, but in its political feasibility. Nearly unprecedented cooperation between local governments, Delta landowners, the refuse removal industry, and state and federal agencies must be achieved in order to make a sufficient quantity of compost available for preservation of the Sacramento-San Joaquin Delta. This political cooperation will ultimately be the essential ingredient required to convert an exciting idea with tremendous potential into an operating reality.

## II. INTERGOVERNMENTAL ORGANIZATION

### A. THE ACTION COMMITTEE

The Action Committee for the Bay Delta Resource Recovery Demonstration was organized in mid-1972 for the purpose of implementing Phase I of a regional solid waste plan presented by the San Francisco Planning and Urban Renewal Association (SPUR), in November 1971. That plan, often referred to as the Bay-Delta Plan, called for regional management of solid wastes, maximum recovery of resources from the solid waste stream, the use of composted Bay Area wastes for island reclamation in the Sacramento-San Joaquin Delta, and the rapid initiation of a pilot project to demonstrate these concepts. The SPUR report recommended the joining together of local agencies to pursue the plan.

Knowing that the Association of Bay Area Governments (ABAG) would be interested in this plan, SPUR had kept them informed of the project as its work went forward. When the SPUR report was published, there was an immediate positive response from the Executive Committee of ABAG, which formally endorsed the proposal. Shortly afterwards, ABAG's solid waste subcommittee set about contacting interested parties to form a group that could implement SPUR's proposed Demonstration project. By August 1972, an ad hoc steering committee for the Bay Delta Resources Recovery Demonstration had formed under the auspices of ABAG. Counties, cities and districts of the Bay Area were invited to join an "Action Committee" and to make a financial contribution to implement Phase I of the Demonstration ($1,500 for jurisdictions with populations under 50,000, $3,000 for jurisdictions with more than 50,000). By the end of 1972, there were 12 active, financially committed members of the Action Committee: the cities of Antioch, Berkeley, Livermore, Oakland, Pleasanton, San Leandro, San Francisco and Vallejo; Contra Costa and Marin

Counties; the East Bay Municipal Utilities District and the Central Contra Costa Sanitary District. (Other members continued to join the Action Committee during the course of the project and a complete list is presented at the front of this report.)

In November 1972, the Environmental Impact Planning Corporation in association with Mr. Frank Stead (original co-authors of the SPUR report) were retained as consultants to assist the Action Committee in its work.

At this point it was assumed that Phase I of the project, the planning stage, would be financed by the members' contributions and that the actual Demonstration, Phase II, would be financed by the United States Environmental Protection Agency's Solid Waste and Resource Recovery Demonstration Grants Program. In December 1972, the Action Committee learned that because of policy changes, the EPA would not fund the Demonstration itself, but was interested in supporting the formation of an intergovernmental agency in the Bay-Delta region with the capability of undertaking the SPUR/ABAG solid waste demonstration and possibly other regional solid waste management activities. The original scope of work of Phase I was revised to encompass and emphasize this concern, and a grant proposal was submitted to EPA. The EPA grant was approved and became effective February 15, 1973.

## B. INVESTIGATION OF ALTERNATIVE INTERGOVERNMENTAL STRUCTURES

### 1. Contacts with Counties

In order to investigate appropriate structures to manage the Bay Delta Resource Recovery Demonstration, the Action Committee appointed an Intergovernmental Structure Subcommittee. The members of the subcommittee decided that as a first step they would establish contact with the people in the counties of the Bay Delta region with responsibility for county solid waste management planning, to inform them of the purpose and objectives of the Demonstration. California's recently enacted Solid Waste Management and Resource Recovery Act (Senate Bill 5) requires all counties in the state to prepare a Solid

Waste Management Plan by January 1, 1976. County plans are required to be consistent with any regional or subregional plans. Subsequently, presentations were offered to elected officials, staff and citizen groups at ten meetings in six counties.

Next, discussions began as to what sort of intergovernmental structure they should propose. In its search for the most suitable intergovernmental structure to raise the necessary funds and manage the Demonstration project, the subcommittee, aided by the consultants, gave consideration to a number of arrangements.

## 2. Alternative Governmental Structures

### a. A multi-purpose regional government with waste management as one of its assigned responsibilities.

This is generally considered to be the most far-reaching intergovernmental arrangement. Such an agency, with taxing and bond-issuing powers, would be equipped to marshal the necessary funds and technical expertise to manage the Demonstration. Cost-sharing could be fairly easily arranged and transition from the Demonstration to a large-scale solid waste disposal plan would be simplified. The resulting consolidation of some existing regional and subregional agencies might be attractive to the private scavengers, since it could lead to reduced bureaucratic regulation. Most political scientists agree that solid waste planning must take place as part of a comprehensive planning process including such areas as land use and transportation. Many engineers interested in establishing efficient systems of solid waste management agree with this concept from a cost/effectiveness point of view. The establishment of a multi-purpose regional agency is an official ABAG goal, and the pending (1972) Knox Bill (AB2040) in the California Assembly would be a step in this direction.

However, this form of regional government is opposed by many as being ahead of its time. Under such an arrangement regional solutions could possibly be imposed upon unwilling local governments. In any case the establishment of such a regional agency would require lengthy legislative consideration. The subcommittee therefore agreed that the creation of regional government or any sort of multi-purpose agency was beyond its scope and powers.

b. A single-purpose regional agency created by state law.

Such an agency would be an efficient structure to concentrate on the Demonstration's work, and would be a good base from which to expand the Demonstration into an eventual, region-wide program. The legislature could structure it to assure local participation, and it could be given independent financing powers.

On the other hand, many feel that any additional single-purpose agencies would compound regional problems more than they would help. Many single-purpose agencies already exist with special, often conflicting and overlapping powers and jurisdictions. Only a tenuous relationship with comprehensive regional planning could be realized. The private sector opposes any additional "layers of government," and legislative approval of such an agency would certainly be difficult. ABAG is strongly opposed to this alternative.

c. A special waste management and disposal district established under existing state legislation governing municipal utility or sanitary districts.

This alternative's chief advantages are that establishment of such an organization would require no new state legislation and the fact that special districts have their own built-in taxing and bonding powers.

But the disadvantages are generally the same as those applying to the single-purpose regional agency--that is, too many special districts have already led to the fragmentation and unnecessary complexity of local services, making the task of coordinated regional planning very difficult. ABAG and the private sector both oppose the addition of any new such licensing or permit-issuing bodies. Formation of either a sanitary or a municipal utility district would require action before the local boards of supervisors and formation elections, another greatly complicating factor.

d. A regional agency established pursuant to the state Joint Exercise of Powers Act.

This alternative was recommended in the SPUR report. It offers the best prospect for a quick beginning, since it consists simply of a contractual agreement between entities. In such an arrangement, membership and management of the Demonstration would be entirely local and voluntary, and no participants would be forced into an agreement. On the other hand, this is a joint powers agreement's greatest drawback. Being entirely voluntary, the agency ultimately agreed upon would lack the necessary power base to effectively implement a regional solid waste program. Dissatisfied members could withdraw at any time, leaving the agency without jurisdiction over that area.

e. Expansion of the present ABAG arrangement to include responsibility for managing the Demonstration project.

Utilizing the existing ABAG structure to manage the project would minimize the time, expense and effort otherwise involved in organizing a new governmental structure. This arrangement could spread the cost of the project over a wide area, as ABAG membership represents the nine-county Bay region. ABAG would lend the project its strength and stature as an already-established on-going entity.

But ABAG is itself a joint exercise of powers agency, and therefore has all of the structural drawbacks noted in the previous section. Some people feel the authority of a joint powers agency is too limited, and if the existing ABAG agreement were used, there would be complications including San Joaquin and Sacramento counties which are also affected by the Demonstration. Also, ABAG's traditional role is one of planning. To actually manage the Demonstration, the ABAG General Assembly would have to agree to this expanded role.

f. A nonprofit corporation.

This arrangement, with a board of directors perhaps made up of ABAG's Executive Committee, could raise its capital from private sources and could give private interests like the scavenger companies a vote in its management, which could not be done under a joint exercise of powers agreement. But such a structure may not be feasible for managing a Demonstration which will operate only two years and has an uncertain future beyond that.

### 3. The Joint Powers Agreement

After reviewing these governmental structures, the subcommittee made no specific choices. Some members expressed a desire to consider the alternative structures as exhaustively as possible in order to choose an organization, refine it, decide how to implement it, and have a foundation on which to build funding plans. Others felt it would be proceeding too quickly to do this. They felt that the costs of the Demonstration and the direct participants should be known before the form of the organization could be chosen. Several members of the subcommittee repeatedly expressed very strong opposition to proposing any sort of structure that might be considered to be beyond the scope of the project, and they wanted to be sure that whatever intergovernmental arrangement was proposed, it not be confused with regional government.

As progress towards selecting an intergovernmental structure was proceeding slowly, ABAG's legal counsel was directed to research what arrangements would be necessary between Action Committee members to serve as a starting point for applications to fund the Demonstration. Legal counsel's resulting suggestion was that the Action Committee reconstitute itself by executing a joint powers agreement, rather than proceed as an "ad hoc" committee.

A point of disagreement developed concerning the purpose of the proposed joint exercise of powers arrangement. Some committee members felt that a joint powers agency was needed that could not only seek funding but manage the Demonstration as well. From this standpoint it seemed logical that the membership should consist of the Bay Area counties, the largest, most powerful local jurisdictions with adequate taxing capabilities. Supporters of the more limited joint powers agreement felt that it would be politically impossible to get the counties into a joint powers agreement at that time.

The latter opinion prevailed and the subcommittee finally recommended that the members of the Action Committee should reconstitute themselves under a joint powers agreement. The Action Committee approved this recommendation, with the understanding that this first joint powers agreement would be simply to help the present members of the Action Committee seek funding for the Demonstration and that a separate intergovernmental institution would eventually be required to actually manage the Demonstration.

A Joint Powers Agreement was subsequently prepared and by November was signed by a sufficient number of the Action Committee members to make it a legal document. The text of the joint powers agreement is contained in the Appendix.

## 4. Approach to the Future

The deliberations of the Action Committee occurred over many months, and by the end of the EPA grant period, no clear agreement emerged as to the kind of intergovernmental organization to be formed for the Demonstration and beyond. The spectrum of opinion ranged from those who saw regional government as a serious threat and wanted only a voluntary arrangement between agreeing local jurisdictions to those clearly in favor of an immediate multi-purpose, limited function, regional structure that would include the management of solid waste as one of its responsibilities.

It might therefore be useful to review some of the concepts of the SPUR report concerning regional management of solid wastes.

1. A regional waste management plan should be carried out in accordance with the following principles:

   a. A new governmental entity is needed to carry out a region-wide wastes management program for the Bay Area.

   b. To the greatest extent feasible, private enterprise should be encouraged to undertake all aspects of solid wastes management--collection, resource recovery and disposal.

   c. Inventive proposals to carry out aspects of the regional plan should be encouraged, and should be evaluated on the basis of their conformity to the regional plan.

2. An intergovernmental entity is needed for regional management of solid wastes for the following reasons:

    a. to manage demonstration projects that would have region-wide application;

    b. to solicit and accept funding from state, federal and other sources;

    c. to allocate costs fairly among local jurisdictions;

    d. to plan comprehensively, including transportation and land use as well as waste processing and disposal;

    e. to facilitate inter-county transfers of waste materials;

    f. to make a systems approach to resource recovery more feasible;

    g. and finally, to eliminate the need for direct federal and state controls.

3. An ultimate regional solid wastes management entity, regardless of its form, should have the following powers and duties:

    a. to arrange for the processing of the region's solid wastes;

    b. to arrange for the building or leasing of a system of regional processing/transfer stations and transport systems;

    c. to set fees sufficient to be self-supporting (which would include the costs of processing and conversion of solid wastes, less income from sales of reclaimed material);

    d. to regulate the selling of all separated materials on the basis of long-term, competitive bids (recognizing that in some cases private processers will pay for wastes to be recycled, and in other cases the public agency may have to pay them to take the wastes);

e. to regulate the processing of all toxic and special wastes so as to recover as much reusable material as possible and also to minimize the toxicity of the residues, and then to dispose of such residues in specially approved sites under rigidly enforced conditions to protect public health;

f. to require that all independent management of wastes (i.e., all wastes not entering the regional management system) meet standards established to protect public health and the environment;

g. to set standards for the manner in which waste materials are to be delivered to the processing/transfer stations after collection from homes, businesses and factories;

h. to encourage and support research and demonstration programs designed to process and recover resources from waste materials in the most efficient manner and at the lowest cost consistent with standards of environmental protection and resource conservation.

For the purposes of the Demonstration project, only a few of the functions of a regional solid waste management entity need be served by the selected intergovernmental structure. These include:

a. the ability to manage the Demonstration project;

b. the ability to solicit and accept funding from state, federal and other sources;

c. the ability to fairly allocate the regional share of costs over local jurisdictions.

From these considerations, four possible intergovernmental structures emerge as the most practical forms to manage the Bay Delta Resource Recovery Demonstration Project. The first involves the establishment of a Joint Exercise of Powers Agency consisting of the eleven counties of the Bay Delta region. The directors of the Agency could be elected officials of the constituent units, or they could be persons chosen by these units of government, either laymen or local officials such as public works directors. The second possibility is that ABAG expand its traditional role of advisory planning to assume stewardship of the Demonstration project. The third possibility is that an eleven-county Joint Exercise of Powers Agency be formed which would contract with ABAG for administrative services. And the last alternative is for ABAG and the San Joaquin and Sacramento Councils of Government to enter into a memorandum of understanding to undertake the Demonstration.

Each of these alternatives would satisfy the requirements of the Demonstration and is suitable for transformation into the solid waste management arm of a possible future regional organization.

# III. THE BAY DELTA RESOURCE RECOVERY DEMONSTRATION PROJECT

## A. SELECTION OF PARTICIPANTS

Due to the high degree of interest in the Demonstration, an equal opportunity to participate was offered to all potentially interested parties through an invitation letter mailed out by the Action Committee in March 1973. This letter described the Demonstration project and listed the criteria that would be used in selecting the final candidates. All cities, counties and sanitary districts of the Bay-Delta Area were invited to make known their interest in furnishing raw materials, or supplying the site for the processing operations. Expressions of interest for transportation systems and Delta land sites were requested from transportation companies and Delta land owners. Invitations were sent to over 300 parties. Those parties that responded with interest were then contacted to determine how they might fit into the Demonstration plan.

The islands that were considered for the project were Mandeville Island, Lower Jones Tract (the portion owned by Allied Properties), Rindge Tract, Bradford Island, Orwood Tract, Woodward Island and Jersey Island. These islands were evaluated on the basis of the following criteria:

- owner interest in land reclamation and levee reinforcement using compost
- how typical the soil and levee conditions were of the Delta
- accessibility by barge, rail or truck
- willingness to participate--no public objections.

On the basis of these criteria, Mandeville Island was ultimately selected by the Action Committee as the site for the Demonstration project.

General views of Mandeville Island.

The island is under single ownership, which simplifies the problem of objections from neighboring land owners. The levee conditions of the island were felt to be serious, yet not so severe as to cause the Demonstration unwarranted risks. The island is conveniently reached by barge. And Al Zuckermann, the owner, has a high interest in experimenting with levee reinforcement using compost refuse.

In selecting source material for the Demonstration, the principle was observed that refuse disposal is primarily a public responsibility, even if disposal operations were contracted to private enterprise. Therefore, offers for source material were solicited from governmental units rather than private disposal operators, although the two often work closely together. The waste source candidates that were evaluated included San Francisco, Berkeley, Oakland, Palo Alto, San Leandro, San Joaquin County, and a joint proposal from Antioch, Pittsburg and Brentwood.

The criteria used to evaluate the source candidates were:

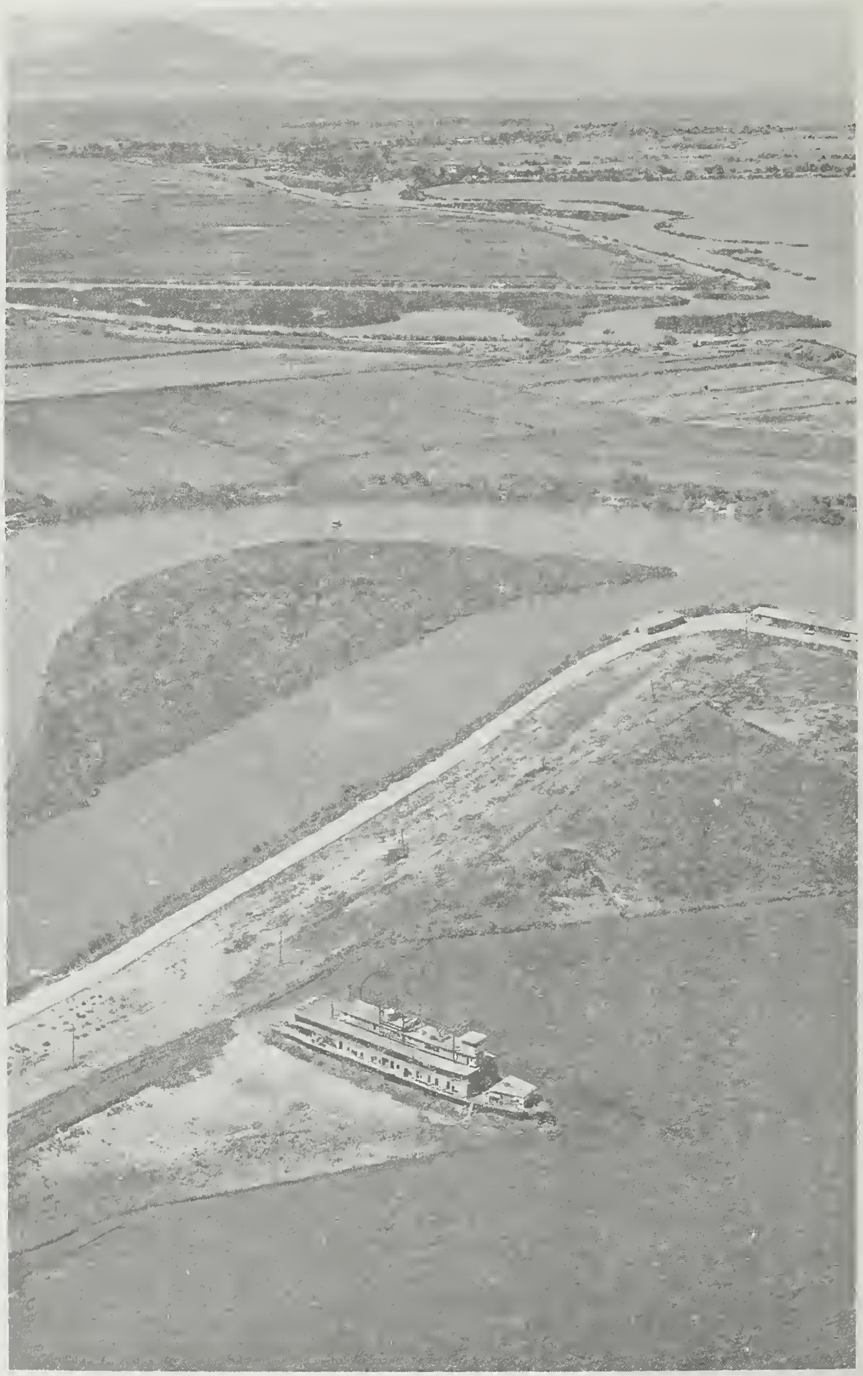
- availability of sufficient refuse and sewage sludge
- availability of a composting site
- readiness to deliver material to the Demonstration
- dependability of supply
- prototype value of the processing operation
- political and geographic regionality
- expandability of supply
- permanence after the Demonstration
- operating coordination of the independent parties
- benefit to the city in keeping its disposal options open
- degree of community interest in the Demonstration
- net cost to the Demonstration.

The process of evaluating the candidates was slow, with a wide range of technical and political factors to be considered. Many communities had joined the Action Committee in hopes of being the selected site. After months of intense competition the candidates narrowed down to three--Berkeley, San Francisco and San Joaquin County. The San Joaquin proposal came from the Countywide Solid Waste Management Committee, but did not have the official endorsement of any city governments in the county or the County Board of Supervisors.

Inner slope of levee at test site on Mandeville Island.

Levee road at test site on Mandeville Island.

Portion of Middle River adjacent to test site on Mandeville Island.



Looking west to Mt. Diablo from Mandeville Island. Paddlewheel boat plugged levee break in the 1930's.

The San Francisco Proposal offered the best materials processing, but at the last minute the intended land for a composting site became unavailable. The City of Berkeley appeared to have assembled the best package proposal, offering a sufficient quantity of refuse and sludge, a transfer station to house processing equipment and, most importantly, a site for composting within its own jurisdiction. Thus, in September 1973, Berkeley was selected as the site for the Demonstration.

However, San Francisco remained keenly interested in participating in the Demonstration and returned to the Action Committee with a proposal that included land for the composting at Sierra Point in South San Francisco. The merits of a two-city demonstration, combining a small urban city with municipal refuse collection and a large metropolitan city with franchised refuse operations, were weighed by the Action Committee and felt to be a more truly regional approach. Finally, in October the decision was reached to conduct the processing and composting operations from both Berkeley and San Francisco. The proposals of each city are contained in the Appendix.

## B. PRELIMINARY SYSTEM DESIGN

### 1. Processing and Resource Recovery

In Berkeley all municipal refuse collected by route trucks would be delivered to a transfer station for processing. This would total about 150 tons per day (46 truckloads, five days per week). An arrangement has been made with the Oakland Scavenger Company to deliver an additional 50 tons per day should it be necessary for the Demonstration.[1] The final design and layout of the transfer station will be developed as part of the Demonstration, but the following preliminary design offers a concept of the operation.

The transfer station should have sufficient floor space for storing one day's refuse and room for the maneuvering of a front loader to begin breaking up material for loading into a primary feed conveyor. The material would feed into a shredding mill to reduce particle size to between two and six inches. The output of the mill is fed into an air classifier to separate the light material from the heavy fraction. The light material, estimated to be 85% of the total, would consist mostly of paper and other organics and a small percentage of light plastics, such as polyethylene film. The light fraction would be conveyed into self-unloading transfer trucks for delivery to the composting site at the Berkeley landfill. The heavy fraction, consisting of metals, glass, rubber, leather and heavy plastics, would pass through a two-stage suspended-type magnetic separator to remove ferrous metals such as tin cans. About 5% of the input refuse is expected to be ferrous metal, which can be sold for remelt to the steel industry. About 15 tons per day of the heavy fraction would remain, and it is unlikely that the small volume of metals and glass could economically be recovered. The heavy fraction that is not recovered for recycling would be disposed of at the Berkeley landfill.

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[1] Newspaper recycling in Berkeley is accomplished by an ongoing program of householder separation and monthly collection and is not considered as part of the Demonstration project.

In San Francisco 150 tons per day of shredded, air-classified organics would be obtained from the existing transfer station, owned and operated by the Sanitary Fill Company.[1] This station currently receives 2,000 tons per day of municipal refuse, about half of which is from residential collection. The residential refuse is delivered to one side of the building and passed through a hammer mill for rough shredding, followed by magnetic separation of ferrous metals. The mill breaks open plastic bags and exposes ferrous material to a three-stage magnetic separator which recovers the metal for sale to the copper industry. An economic feasibility study on further resource recovery is currently being conducted by the San Francisco Scavengers under an EPA grant. If the study proves positive, the operators would install their own equipment for further shredding, air classification and recovery of aluminum and other non-ferrous metals and possibly glass. One hundred and fifty (150) tons per day of the light organic fraction from the air classifier would then be diverted for use in the Demonstration. If the study indicates the economic infeasibility of installing this resource recovery equipment, the Demonstration would require the addition of a small shredding and air classification operation to the existing transfer station to produce the 150 tons per day of shredded organics. In either event, the material would be loaded into self-unloading vehicles for transport to a composting site at Sierra Point, about two miles away.

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[1] As in Berkeley, newspapers are collected separately for recycling in San Francisco, and this operation is not included as part of the Demonstration project.

### 2. Composting

Composting is the high-speed decomposition of organic wastes to render a stable, dark-brown humus product. This is accomplished by mechanical processing to maintain proper environmental factors of moisture, aeration, temperature, pH level and carbon:nitrogen ratio. It is the control of these variables that distinguishes composting from the natural decomposition that occurs in an open dump, a sanitary landfill or a manure heap.

At both the Berkeley and Sierra Point sites, up to 50 tons per day of partially de-watered sewage sludge (20% solids) would be mixed with the organic refuse during the composting process. In Berkeley, sludge would be delivered from the East Bay Municipal Utility District's secondary treatment plant in Oakland. At Sierra Point, sludge would be delivered from San Francisco's southeast sewage treatment plant, a primary treatment facility.

Many different types of composting systems have been developed in the United States and Europe to achieve stabilization of organic wastes. The system chosen for the Demonstration is aerobic windrow composting. Aerobic composting is characterized by high temperatures (140°F to 170°F), absence of foul odors and prompt decomposition (a matter of days or weeks depending on the mechanical assist and the maintenance of proper environmental factors).

The size and method of operation of a windrow composting facility depend on the type of equipment used for turning the windrows. The two predominant pieces of equipment on the market are the General Motors Terex-Cobey and the Aerobie marketed by AENCO of Wilmington, Delaware. The Terex-Cobey is a rugged machine of proven capability. However, preliminary estimates indicate that its operation requires about twice the land area of the Aerobie because it cannot completely turn a pile in a single pass as can the Aerobie. As land requirement may become a limiting factor in composting all of the Bay Area's wastes, the Aerobie is referred to in the following discussion. This description is set forth only as a concept and, as such, may be altered when contracts are let for final design and engineering of the facility. This discussion applies to both San Francisco and Berkeley operations.

### Compost Yard

The composting operation would occur in a paved and enclosed composting yard. A 250-foot by 500-foot area is probably sufficient. Asphalt paving would provide a smooth surface to allow for a clean operation. A 1% grade would provide for proper drainage of rain water and leachate into holding tanks so that no wastewater discharge from the operation would result. The yard should be enclosed to catch any blowing shreds of paper. This can be accomplished with a cable-supported wire mesh structure. There should probably be solid walls for the first 12 feet of sidewall and then screening, including a roof, above that. Experience may show that such an enclosure is unnecessary, but it is included as a precaution against possible nuisance.

### Refuse-Sludge Mixing

Shredded refuse and dried sludge would be trucked to the composting yard and mixed together in the form of a rough windrow. This would be consolidated by a skip loader feeding the Aerobie, which would give the waste its first churning, add moisture and form the windrows.

### Windrow Turning

The windrows should be turned every few days for a period of about three weeks. This is accomplished by the Aerobie composter, which drives down the windrow, straddling it and passing material by a cylindrical drum with teeth that shreds the refuse and forms a vertical-walled windrow, 9 feet wide by 9 feet high, behind it. The Aerobie turns the complete windrow each time it advances through it. The machine has a hose and reel system rigged to it for squirting water into the refuse as it is being turned. This is important because the initial refuse-sludge mixture has about 25% moisture, and about 50% is recommended for efficient composting. During the rainy winter months, runoff water captured in the leachate ponds can be recycled back into the windrows; in dry periods fresh water can be used.

## Degree of Stabilization

Temperature is probably the best single indicator of the degree of stabilization during the composting process. As soon as the refuse and sludge are mixed into the windrow, bacterial activity proceeds at an accelerated pace. In composting studies conducted at the University of California in 1953,[1] the temperature generally rose from ambient to 60°C or 70°C within four days. These high temperatures, which are characteristic of good aerobic composting, result from excess energy released by the bacteria as they consume the organic matter. When the "food supply" is consumed, bacterial activity declines and the temperature drops accordingly. The resulting compost is dark brown in color and has an earthy odor like rich soil. The exact frequency of turning and length of detention to achieve this state are determined by the skill and experience of the operator, coupled with laboratory tests. The compost plant is like a sewage treatment plant or perhaps more poetically, like a winery. Proper control of the biologic regime depends on skilled management supplemented by scientific testing.

## Screening

When the compost is sufficiently stabilized, it should be screened to remove sheet plastic and oversize particles before being loaded on the barge. This is done by loading the compost into a large shaker screen that vibrates the smaller material through it and removes larger particles. The screened compost is then loaded into a barge. The residuals would require disposal. In Berkeley this would entail hauling to the disposal area of the landfill; in San Francisco it would involve backhauling to the transfer station by the trucks delivering the shredded refuse. Approximately 100 tons of screened compost per day would be produced at each site.

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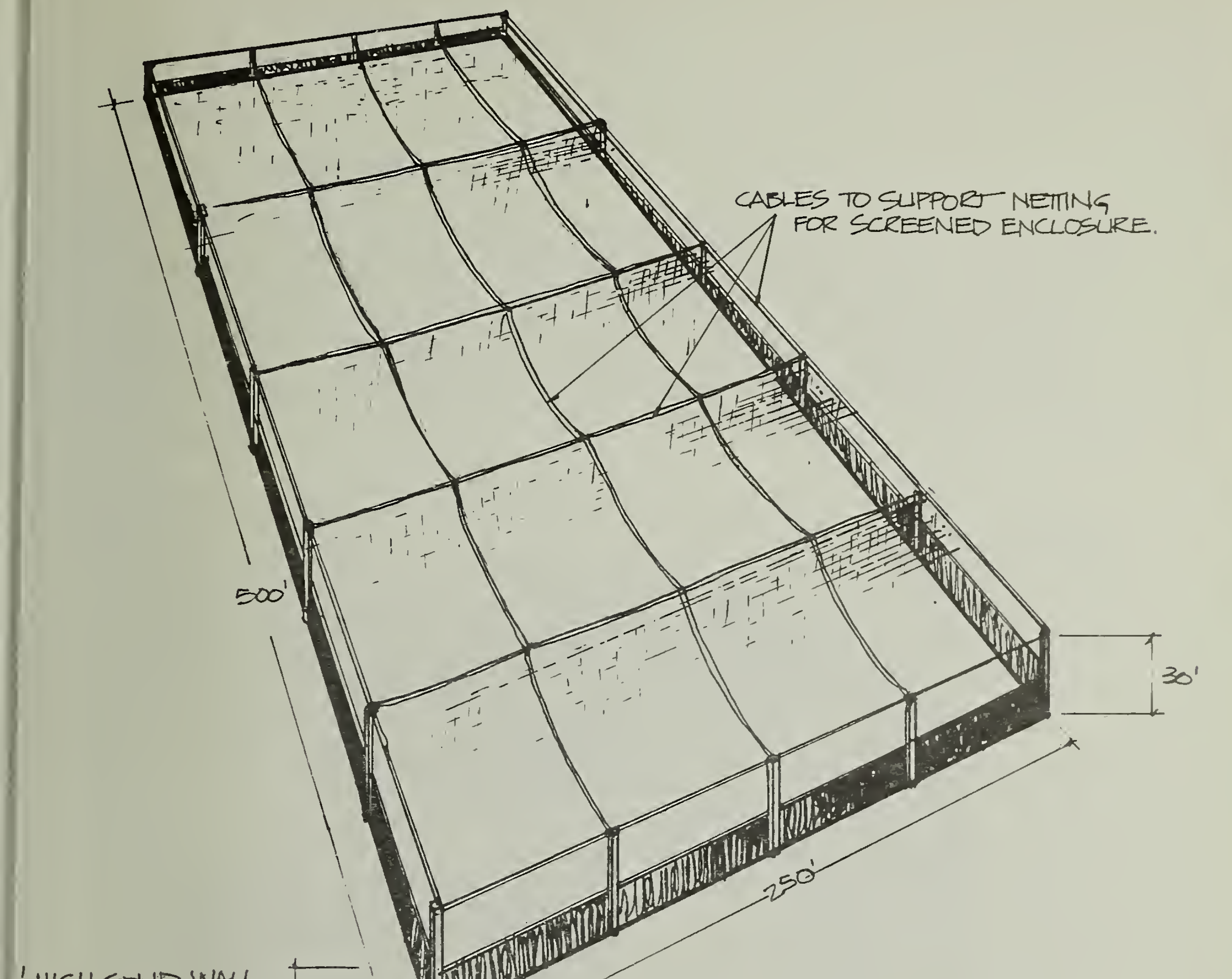
[1] P. H. McGauhey and C. G. Golueke. Reclamation of Municipal Refuse by Composting, Technical Bulletin No. 9, SERL, UC Berkeley, 1953.

Compost, compressed to simulate field conditions, shown under a 9.5 kilogram load.

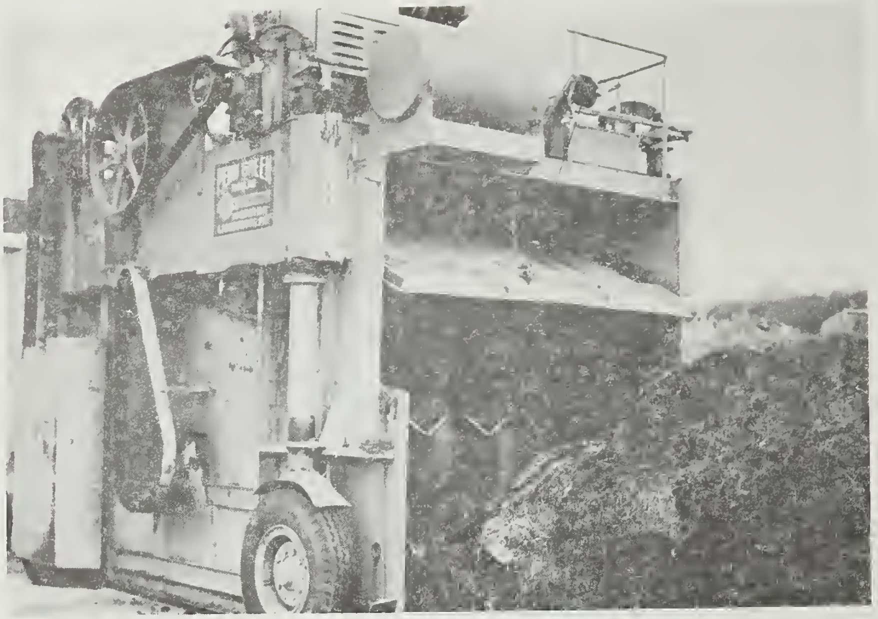
Sample of compost produced from shredded, air-classified refuse and sewage sludge.


CABLES TO SUPPORT NETTING FOR SCREENED ENCLOSURE.
500'
30'
250'
! HIGH SOLID WALL
3/4" CABLE SUSPENSION
22-24' OR HIGH ENOUGH FOR A 5-AXLE DUMP TRUCK TO CLEAR
250'

**Composting Yard** **Figure 6**

**Bay Delta Resource Recovery Demonstration Project**

eip / ABAG



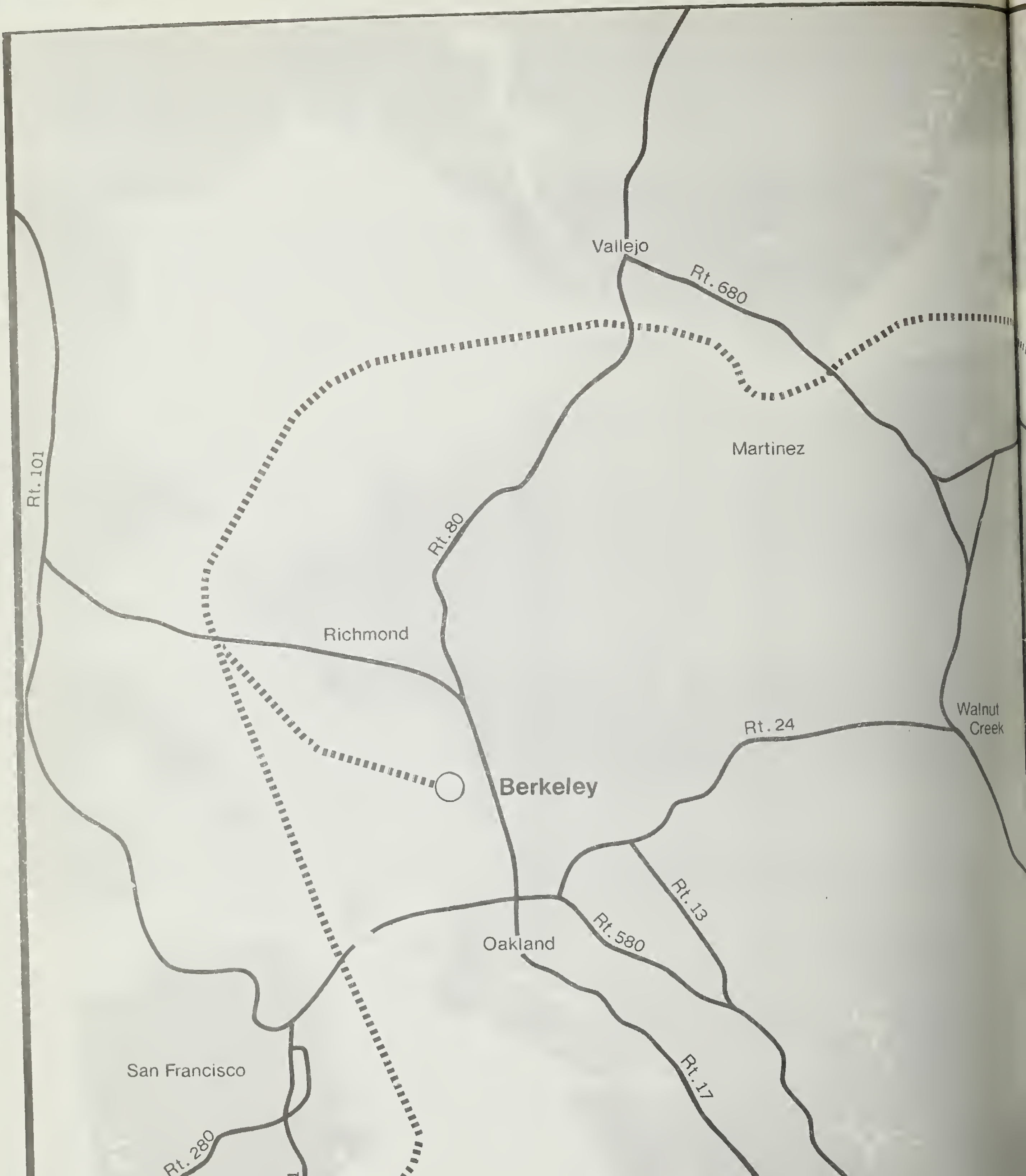
Composting Vehicle Operating on a Windrow.

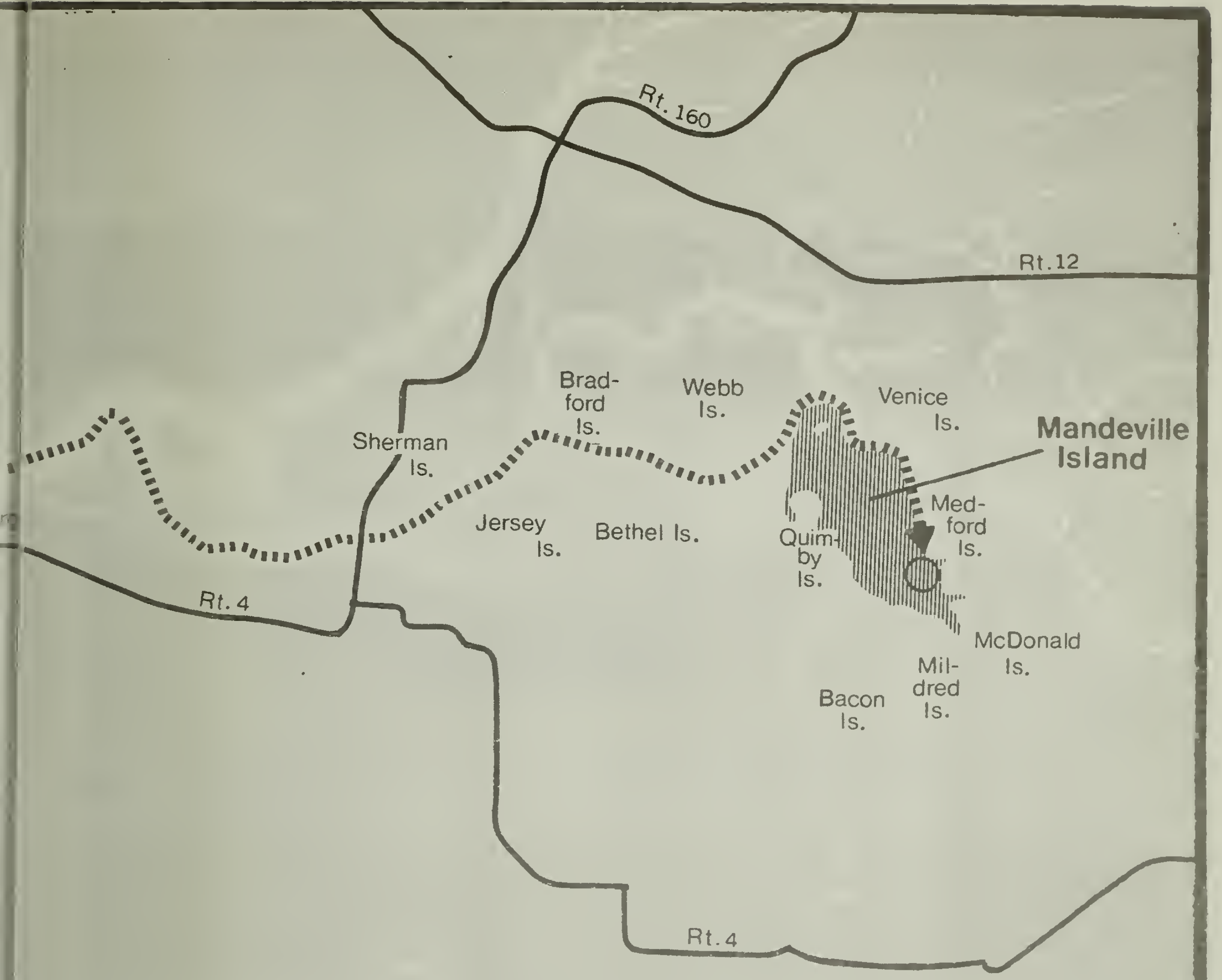
### 3. Transport to Delta

Compost from each site would be loaded into a 600-ton barge docked in the adjacent waterway and shipped once a week to Mandeville Island. This transportation method is cheaper, more reliable during winter operations and is less energy-consuming than truck haul. The following discussion is presented as a concept of how the barging operation could be performed and, as with composting, may be altered in the final design.

The compost will be hauled from the composting area to the barge by dump truck. The sides of the truck can be extended so that it will have a capacity of 37 cubic yards; this would hold 12 1/2 tons of compost. As these trucks will not be subject to any overhead limitations, it is suggested that the sides be extended an additional two feet to prevent loss of material. The truck is loaded by the composting crew, then backs up a ramp and dumps its load into the barge. Waterfront men will move the barge to obtain an even distribution. The compost should be damp when loaded to prevent loss. A shroud over the ramp and canvas chute hanging down into the barge would help prevent loss during the tow. Dolphins, a small wharf, a truck ramp, a double drum winch and miscellaneous tools and rigging will be needed at the waterfront. One truck driver and two waterfront men should be sufficient labor for the pilot operation. A breakwater at the Berkeley site may be required to protect the loading facility. Two barges will be needed for each site, one being loaded at the composting site while the other is at Mandeville Island being unloaded. One tug will be needed to make one tow per week from each site. It is assumed that dry-docking and repairs can be made on weekends.

Compost would be unloaded at Mandeville Island by a 35-ton truck crane mounted on a wharf. Compost would be removed by clamshell bucket and loaded into a dump truck. The truck would drive onto a trestle extending into the island and would dump the compost onto the island surface. A concrete crossing may be needed on the levee to support the constant truck traffic and to support one end of the long steel girders from the wharf and trestle.

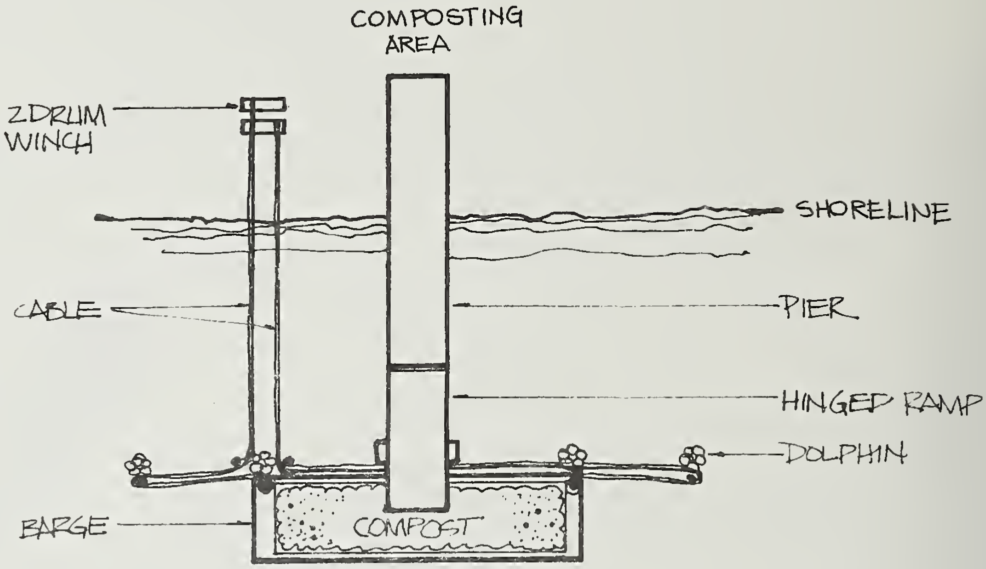

Vallejo
Rt. 680
Martinez
Rt. 101
Rt. 80
Richmond
Walnut Creek
Rt. 24
Berkeley
Rt. 13
Rt. 580
Oakland
Rt. 17
San Francisco
Rt. 280
Rt. 101
Sierra Point



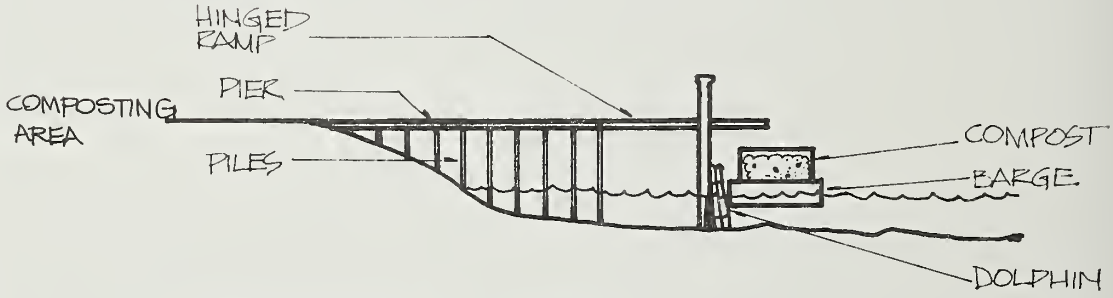
**nsport Barge Route** **Figure 8**

**Delta Resource Recovery Demonstration Project**

**/ ABAG**



PLAN VIEW

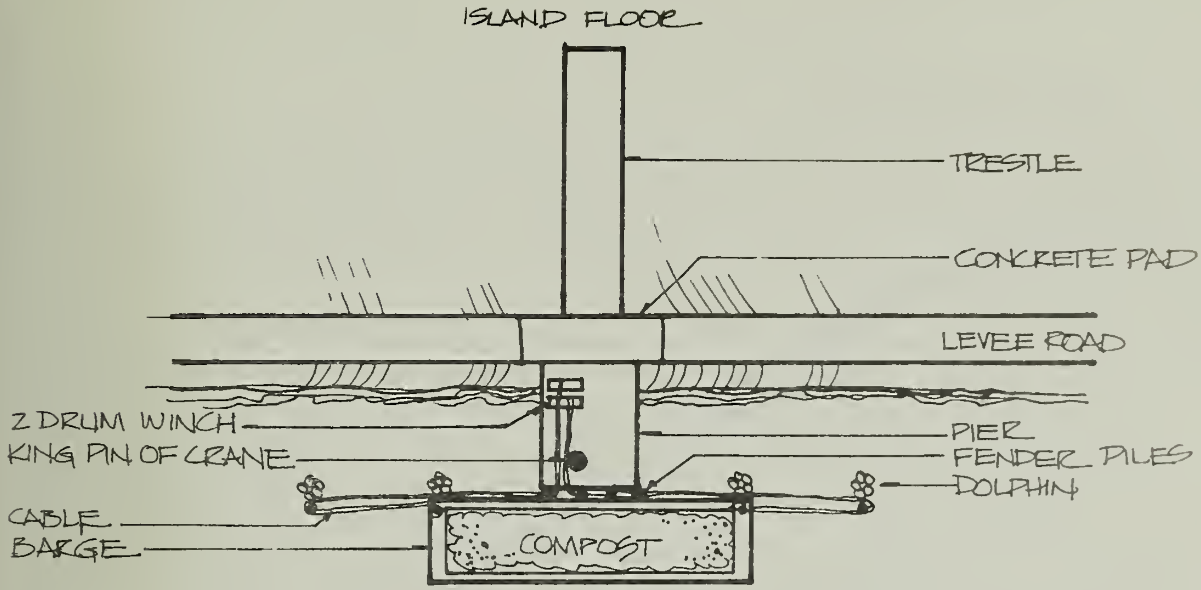


SECTION VIEW

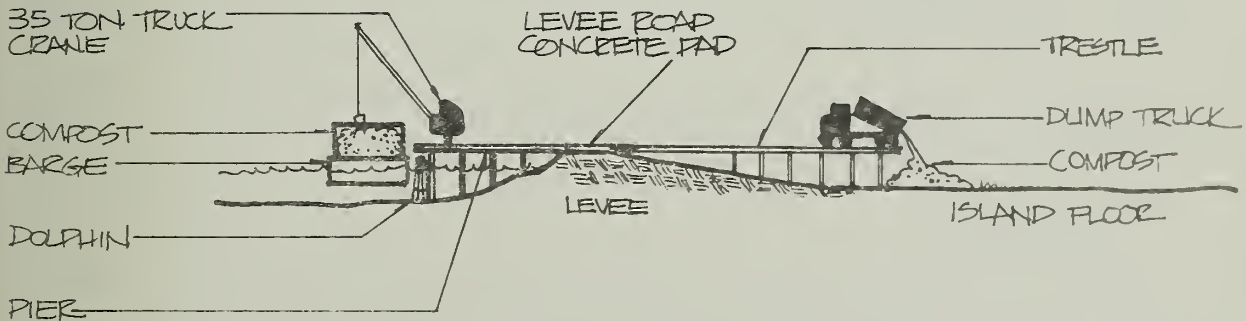
**Barge Loading Concept** **Figure 7**

**Bay Delta Resource Recovery Demonstration Project**

**elp/ABAG**



PLAN VIEW



SECTION VIEW

**Unloading Barge Concept** **Figure 9**

**Bay Delta Resource Recovery Demonstration Project**

**eip/ABAG**

## 4. Berm Construction

Compost delivered to Mandeville Island would be used to construct a berm behind a test section of levee. The purpose of the berm is to strengthen the levee against failure from high water pressures in the outside water channel and to serve as a new agricultural soil.

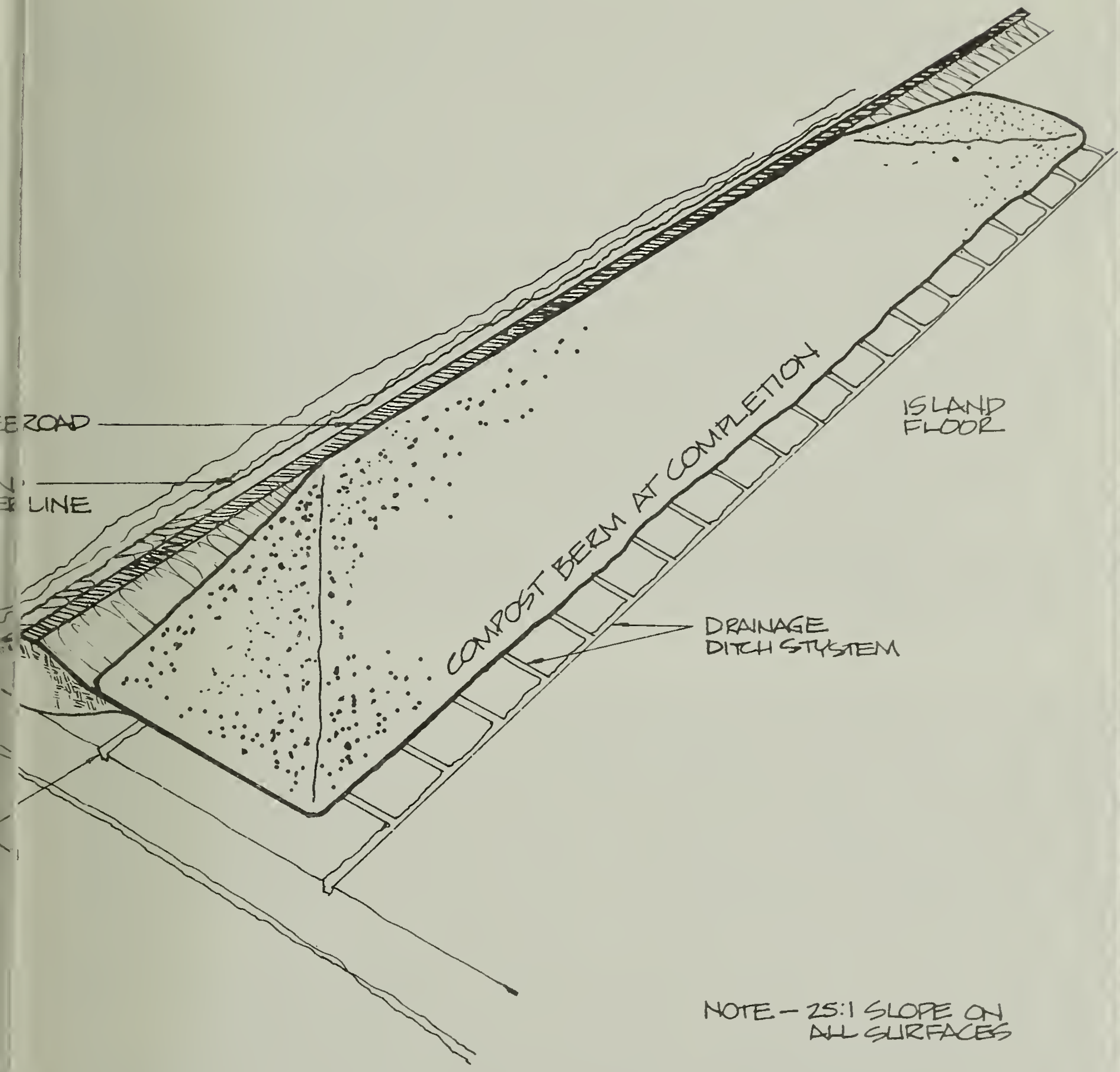
The berm would be built with a uniform slope of 25 horizontal to 1 vertical from the crest of the levee to the island floor. As the levee is approximately 20 feet high, the berm would extend 500 feet inland from the levee crest. Compost would be moved from the base of the trestle to the placement area by a scraper vehicle and applied in wide broad layers approximately one foot thick. A crawler tractor would compact the compost to the required density. Before the compost is applied, a drainage system should be constructed to prevent water pressures from building up beneath the berm where seepage may emerge from the levee and the adjacent ground.

Nonuniform settlement due to compression of the underlying peat would probably cause cracking of the levee and repair of these cracks would be a necessary part of the construction operations. To prevent failures of the peat under the weight of the compost fill, the berm would have to be constructed slowly. All slopes, whether permanent or temporary, would have to be gradual. If the berm is built to the levee crest, approximately 1,800 feet of levee could be reinforced over a two-year period.

An office trailer and graveled pad for vehicle parking would also be constructed at the site.

## 5. Monitoring

Monitoring of air quality, water quality, soil stability and biotic impacts would be conducted to determine the environmental and engineering effects of the compost berm. Knowledge would also be gained about the extent of composting required, materials handling techniques and levee reinforcement procedures that could be applied to a full-scale operation. After emplacement, as the surface of the compost decomposes and weathers into a soil-like mantle, the agricultural productivity of the material would also be monitored to determine the agricultural worth of compost as a parent material base for the development of new agricultural soil.



**Compost Berm Concept** **Figure 11**

**Bay Delta Resource Recovery Demonstration Project**

**ip/ABAG**

a. Water Quality

The purpose of the water quality studies is to determine the water pollution potential of the compost berm--its variation with compost age, degree of compaction, fluctuation of the ground water level and the rate of downward percolation of surface water.

The following assumptions underlie the design of the proposed water quality studies:

- The compost as it arrives at the island is sufficiently stable to produce no new liquid leachate although it still contains leachate in its absorbed water.
- Above the zone of saturation in the water profile of the berm, the compost will remain aerobic in upper layers and aerobic or anaerobic in the lower layers; in the zone of saturation it may become anaerobic.
- Once the surface of the berm is planted with crops, agricultural chemicals will be applied as needed to promote crop growth.
- All application of water to the berm for irrigation or salt leaching will be overhead or to the surface.

Water quality monitoring would involve three types of tests. First, tests would be conducted on the composting process itself. This would include sampling of both the solid material and leachates. Second, lysimeter tests would be conducted to determine the water pollution potential of the compost berm behind the levee. A lysimeter tank would be filled with compost to simulate the berm and would operate with either downward percolation of applied water or with complete saturation of the bottom layers. Third, full-scale site tests would be conducted prior to and during compost placement. A network of sampling points would be established to permit the sampling of applied water, drainage water and ground water around the test levee site. These tests will furnish information on current water pollution levels which can be used to compare the net increment imposed by the compost berm. Laboratory measurements of water quality would be grouped as follows:

- toxicants (heavy metals, phenols, phthalates),
- pesticides (chlorinated hydrocarbons, polychlorinated biphenyls),

- biostimulants (nitrogen, phosphorous),
- oxygen-consuming potential (TOC),
- pathogens (coliform),
- mineral solids (electrical conductivity).

### b. Air Quality

The purpose of air quality monitoring during the Demonstration is to investigate what effect the use of compost will have on the air quality of Mandeville Island and the Delta, both during the unloading and placement procedure and subsequently after the fill is in place and begins to weather into soil.

Monitoring by visual observation is the most realistic procedure for evaluating air quality during compost unloading, placement and compaction. Observations should be made under both mild to moderate winds (generally under 10 to 15 MPH when there is little or no wind erosion taking place from bare peat soils) and under strong winds (generally over 15 MPH when dust is likely to erode from dry bare peat soils).

The degree of dust pollution can be evaluated by the subjective judgment of changes in color, visibility (through the air mass) and reflection characteristics. Attention should also be directed toward the wind erodibility of small bits of thin plastic film.

After the reinforcement of a section of the levee is completed and the final surface attained, the surface is expected to slowly weather into a soil-like mantle. The wind erodibility of this developing surface can be compared with that of nearby peat soils by the use of simple impinger samplers placed at ground level, with procedures similar to those used by A. B. Carlton of the University of California during his study of peat dust in the late 1950s.

### c. Soil Stability

A number of field studies should be undertaken during the course of the Demonstration to monitor the effects of the berm:

- Settlements, horizontal movements and spreading of the levee crest should be monitored carefully during the entire project. Construction should be halted if the settlements exceed those predicted or if the lateral movement of the water side of the levee crest exceeds five feet. Construction should only be resumed if a careful study indicates that failure of the levee is not impending.

- A thorough program of crack surveillance and repair should be conducted continually during construction and after construction. The best method for detecting and repairing cracks will require further study before and during construction, but it is clear that extensive cracking could weaken the levees considerably, and this matter will require very careful attention.
- Piezometric levels in the drains and in the peat beneath the berm should be observed to insure that the water pressures are in fact maintained at low, safe levels by the drainage system.
- Densities and water contents of the compost should be measured on a regular basis, and supervision should be provided to insure that the densities measured are representative of the entire fill.
- In-situ permeability tests should be performed in the peat, the compost and the drain materials using the falling head permeability procedure with standpipe piezometers.
- The settlements at the toe of the levee should be monitored to check the accuracy of settlement predictions.

### d. Agricultural Productivity

Agricultural productivity experiments would be conducted in the lysimeters used for measuring the quality of compost leachate. The purpose of these experiments is to obtain preliminary information on how compost would behave as an agricultural soil. In the first year barley may be the only feasible crop, and its yield will be depressed due to the high organic content of this new soil. Particular attention should be paid to plant toxicity due to possible uptake of heavy metals from the compost. Leaf analysis should also be conducted for possible concentrations of elements toxic to animals but not to plants (e.g., molybdenum, arsenic and selenium). The need for mixing Delta peat, dredged sand or fertilizer with the compost material and irrigation requirements would be investigated to obtain preliminary information for later field research.

Once a section of test berm has been built behind the levee, experiments would be initiated to determine crop response under field conditions and to determine proper agricultural practices on an elevated section of Delta land. Normal crops of the area should be grown (asparagus, corn, milo, tomatoes, oats and barley). Crop and soil responses would be monitored to determine farming modifications that may be necessary.

### e. Biotic Effects

A comprehensive monitoring program would be conducted to provide data on the transportation of PCBs, phthalate acid esters, heavy metals and organochlorine residues from the compost material into the surrounding Delta environment. The monitoring must be initiated prior to any deposition of compost material, and be conducted for a time period adequate to compensate for the time-lag involved in the leaching processes. The program should be structured as follows:

- The establishment of a number of monitoring stations in the vicinity of the test site to monitor pollutant levels of soil and sediment samples. Samples taken prior to the project will indicate the undisturbed background levels, and it is recommended that these samples be taken along a transect at varying distances from the test site and at a frequency adequate to permit reliable statistical evaluation of the data. Emphasis must be given to soil and sediments rather than water, as the latter is known to be unreliable for the investigation of pollutant contamination levels in wildlife.
- Determine pre- and post-study pollutant concentrations in a carefully selected animal "indicator" species. Samples of a single or several indicator species must be taken from downstream and upstream of the study site at frequent intervals to provide reliable data on the trends and the distribution of pollutants. The indicator species selected should be a resident (and not a mobile animal), one that can be easily collected (i.e., abundant) and preferably a filter feeder. Potential candidates include a mollusk, the Asiatic clam (Corbicula fluminea), the crayfish (Pacifastacus leniusculus), the mysid shrimp (Neomysis awatschensis) or the amphipod

(Corophium).[1] The mysid shrimp is probably the ideal species since it is a major food item of striped bass, American shad, green sturgeon, channel catfish, black crappie and warmouth.[2] Analyses based on highly mobile or predatory fish are not reliable as it is impossible to isolate the source of contamination. It is imperative that the sampling be statistically defensible and provide information on the ecological impact of any contaminants introduced by the compost.

- By sampling, determine the daily input of pollutants contained in the sewage sludge and dry solid wastes to provide essential background data.

## C. ECONOMIC ANALYSIS AND PROPOSED FUNDING

### 1. Estimating Approach

The cost of conducting the pilot-scale Demonstration has been estimated in terms of the funds that need to be raised. Contributions in cash, facilities, manpower and services provided by donor cities and scavengers have not been included in this estimate.

The costs of the system are broken down into capital expenses, annual operating costs and credits to the system. Operating costs are calculated for a two-year period from the time facility construction and equipment check-out are completed. As the Demonstration would occur over a relatively short period of time, it is assumed that equipment would be rented or contracted rather than purchased whenever possible.

Credits to the system have been computed for sale of ferrous material reclaimed by Demonstration-funded equipment. It is also assumed that capital equipment would have a salvage value at the end of the Demonstration, either from dismantling and sale of equipment or from payment by another agency that would take over the operation of the system. Credits have not been assigned for savings in disposal costs, environmental enhancement or other factors which would not affect the funding needed to be raised for the Demonstration. All costs are expressed in terms of 1973 dollars.

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[1] California Department of Fish and Game, Ecological Studies of the Sacramento-San Joaquin Estuary, *op. cit.*

[2] *Ibid.*

## 2. Summary of Estimated Cost

The total cost of the Demonstration is estimated to be $6.9 million as shown in the following table.

| | (A) Capital Costs | (B) Annual Operating Costs | (C)=(A)+2(B) Total Cost |
|---|---|---|---|
| Processing/transfer station | 253,000 | 162,000 | 577,000 |
| Composting | 2,250,000 | 692,000 | 3,634,000 |
| Barge transport | 500,000 | 545,000 | 1,590,000 |
| Compost placement | 110,000 | 200,000 | 510,000 |
| Monitoring | 54,000 | 170,000 | 394,000 |
| Project supervision | --- | 50,000 | 100,000 |
| Other | 25,000 | 25,000 | 75,000 |
| Project Total ($) | 3,192,000 | 1,844,000 | 6,880,000 |

## 3. Cost Analysis

The cost estimate is presented according to the principal functions of the Demonstration: (a) refuse processing, (b) composting, (c) barge transport, (d) compost placement on the island, (e) monitoring, (f) project supervision and (g) other expenses. The estimate is based on the following assumptions for Berkeley and San Francisco:

### Berkeley

- Berkeley provides at its own expense land and a building for a processing/transfer station located in its industrial area and land for a composting facility at its landfill.
- The Demonstration pays for the cost of equipment in the transfer station, operation of the transfer station, transportation of shredded material to

the composting facility and operation of the composting facility.
- Refuse is fine-shredded in the transfer station and ferrous materials are removed magnetically for sale to the steel industry.
- Sludge is delivered to the composting facility by the East Bay Municipal Utilities District at the District's own expense.
- Barging from the landfill is the mode of transportation.

San Francisco

- A mill and air classifier will be installed at the transfer station as a result of the material recovery study being conducted by the San Francisco refuse firms.[1]
- Shredded refuse and sludge are delivered to the composting site at no cost to the Demonstration.
- Land at Sierra Point is available for lease at $1 per year.
- Compost is barged from Sierra Point to Mandeville Island.

### a. Processing/Transfer Station

This will apply to Berkeley only since San Francisco already has an operational transfer station.

Capital Costs

| | |
|---|---|
| Scale | $ 15,000 |
| Feed conveyor 360 feet$^2$ @ $117/feet$^2$ | 42,000 |
| Mill (25 tons/hour) | 70,000 |
| Output conveyor 80 feet$^2$ @ $117/feet$^2$ | 9,000 |
| Two-stage magnetic separators | 20,000 |
| Electrical controls | 15,000 |
| Office and service equipment | 10,000 |
| One front loader | 60,000 |
| Contingency @ 10% | 24,000 |
| Engineering and startup @ 20% | 48,000 |
| Total | $313,000 |
| Less salvage value after two years: | |
| transfer station equipment - $241,000 @ 25% | -60,000 |
| Total Capital Costs | $253,000 |

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[1] A small shredding facility must be added to the existing transfer station if the refuse firms do not add their own resource recovery system. Estimated cost is $150,000.

### Annual Operating Costs

| | |
|---|---|
| Labor - 3 men @ $20,000 | $ 60,000 |
| Maintenance and operation mill @ 50¢/ton | 20,000 |
| Other maintenance @ 10% of equipment cost ($171,000) | 17,000 |
| Power - 11 kwh/ton x 39,000 tons @ 25¢/kwh | 11,000 |
| Transport to compost area - truck and driver @ $25/hour x 10 hours/ day x 260 days | 63,000 |
| Contingency @ 20% | 34,000 |
| Total | $205,000 |
| Less sale of ferrous material: 150 tons/day x 5% ferrous x $20/ton net price x 260 days | -43,000 |
| Total Annual Operating Cost | $162,000 |

b. Composting

### Capital Costs - Berkeley

| | |
|---|---|
| Yard | |
| paving, screened enclosure, leachate tanks 125,000 feet$^2$ @ $3/feet$^2$ | $ 375,000 |
| sludge mixing facility | 50,000 |
| maintenance facility | 25,000 |
| Equipment | |
| 3 composting machines @ $80,000/each | 240,000 |
| 2 front loaders @ $80,000/each | 160,000 |
| pumps and piping | 20,000 |
| portable screen and conveyors | 50,000 |
| pickup truck and automobile | 6,000 |
| Contingency @ 10% | 93,000 |
| Engineering and startup @ 20% | 186,000 |
| Total Capital Costs (Berkeley) | $1,205,000 |
| Less salvage value after two years: composting equipment - $476,000 @ 25% | -119,000 |
| | $1,086,000 |

## Capital Costs - San Francisco

| | |
|---|---|
| Yard | |
| paving, screened enclosure, leachate tanks 125,000 feet$^2$ @ \$3/feet$^2$ | \$ 375,000 |
| sludge mixing facility | 50,000 |
| maintenance facility | 25,000 |
| Equipment | |
| 3 composting machines @ \$80,000/each | 240,000 |
| 2 front loaders @ \$80,000/each | 160,000 |
| pumps and piping | 20,000 |
| portable screen and conveyors | 50,000 |
| pickup and automobile | 6,000 |
| Utility hookup - water and electricity | 60,000 |
| Contingency @ 10% | 99,000 |
| Engineering and startup @ 20% | 198,000 |
| Total Capital Costs (San Francisco) | \$1,283,000 |
| Less salvage value after two years: | |
| composting equipment - \$476,000 @ 25% | -119,000 |
| | \$2,250,000 |

## Operating Cost - Berkeley

| | |
|---|---|
| 12 men @ \$20,000/year | \$ 240,000 |
| Maintenance and operation @ 10% of equipment cost (\$476,000) | 48,000 |
| Contingency @ 20% | 58,000 |
| | \$ 346,000 |

## Operating Cost - San Francisco

| | |
|---|---|
| Same as Berkeley | \$ 346,000 |
| Total Operating Cost | \$ 692,000 |

### c. Barge Transport

#### Capital Costs

| | |
|---|---|
| Berkeley loading facility - wharf, dolphins, winch, etc. | $150,000 |
| San Francisco loading facility - wharf, dolphins, winch, etc. | 150,000 |
| Island unloading facility - wharf, dolphins, trestle | 200,000 |
| Total Capital Cost | $500,000 |

#### Operating Cost - Berkeley

| | |
|---|---|
| Move compost to barge: truck and driver @ $25/hour x 8 hours/day x 260 days | $ 52,000 |
| Barge loading: 2 men @ $25,000/year | 50,000 |
| Tug towing: 20 hours @ $80/hour x 52 weeks | 83,000 |
| Two 600-ton barges @ $1,500/month x 12 months | 36,000 |
| Total Operating Cost (Berkeley) | $221,000 |

#### Operating Cost - San Francisco

| | |
|---|---|
| Move compost to barge: truck and driver @ $25/hour x 8 hours/day x 260 days | $ 52,000 |
| Barge loading: 2 men @ $25,000/year | 50,000 |
| Tug towing: 22 hours @ $80/hour x 52 weeks | 92,000 |
| Two 600-ton barges @ $1,500/month x 12 months | 36,000 |
| Total Operating Cost (San Francisco) | $230,000 |
| Island Unloading: truck crane and dump-truck @ $9,800/week x 52 weeks | $ 94,000 |
| Total Annual Operating Cost | $545,000 |

### d. Compost Placement

| | |
|---|---|
| Capital Costs - drainage system under berm - 10,000 feet @ $11/foot | $110,000 |
| Operating Costs - scraper, grader and water wagon @ $3,850/week x 52 weeks | $200,000 |

### e. Monitoring

#### Capital Costs

| | |
|---|---|
| Project office and parking area | $ 15,000 |
| Furniture and supplies | 9,000 |
| Test equipment | 30,000 |
| Total Capital Costs | $ 54,000 |

#### Operating Costs

| | |
|---|---|
| Water quality | $ 35,000 |
| Air quality | 15,000 |
| Agricultural worth | 20,000 |
| Soils monitoring | 50,000 |
| Biotic monitoring | 50,000 |
| Total Operating Costs | $170,000 |

### f. Project Supervision

| | |
|---|---|
| Annual Operating Cost | $ 50,000 |

### g. Other Costs

#### Capital Costs

| | |
|---|---|
| Other expenses such as management costs for program implementation | $ 25,000 |

#### Annual Operating Costs

| | |
|---|---|
| Island land leasing: 20 acres @ $50/acre | $ 1,000 |
| Island road maintenance: 2 miles @ $1,000/mile | 2,000 |
| Miscellaneous (insurance, fees, etc.) | 22,000 |
| Total Annual Operating Cost | $ 25,000 |

### 4. Cost Allocation

The Demonstration has two broad objectives: to open up a new method of disposing of organic solid waste by conversion to a usable material; and to show that there is a permanent and unlimited "market" for this material in the preserving, replacement and upgrading of soil mantle.

The first objective serves primarily the communities that produce solid wastes; the second objective serves the broader interest in land productivity.

The two objectives taken together clearly involve local, state and federal interests, and the costs of the Demonstration should therefore be allocated equitably among these three levels.

Because the federal government is the owner of such a large portion of this nation's land, because it is so deeply involved in agricultural production and because of its interest in the loss of soil from strip mining operations, it is eminently clear that the federal government should bear at least 50% of the cost of the Demonstration.

The state government also has an unusually high stake in this Demonstration. In recent legislation it has called for a new approach to solid waste management which will give major emphasis to resource conservation. The unique level of state interest in this Demonstration, however, concerns the Delta. The Delta is a vital link in the state's fisheries, its food production, its recreation, its industry and its transportation, and it is the very heart of the state's total water resources.

For these reasons, the state's and region's 50% of the Demonstration cost should be divided, not 25% and 25% as previous precedent might suggest, but on the far more logical and equitable basis of 40% and 10%, respectively.

Regional costs should be distributed over the area that stands to benefit from a successful Demonstration. This includes the entire Bay-Delta region, involving the nine Bay Area counties and the two Delta counties of San Joaquin and Sacramento.

In view of the state's legislated policy of regional solid waste management cooperation through county units established by Senate Bill 5, it is recommended that the regional share of the Demonstration cost be allocated on a county-by-county basis.

The estimated $6.9 million for the Demonstration would need to be allocated over a period of three fiscal years--one year for construction and startup operations and two years for operation of the Demonstration. The yearly project cost would then be:

| | % of Total | Cost Per Year | 3-Year Total |
|---|---|---|---|
| Federal | 50% | $1,147,000 | $3,440,000 |
| State | 40% | $ 917,000 | $2,752,000 |
| Regional | 10% | $ 229,000 | $ 688,000 |
| Totals | | $2,293,000 | $6,880,000 |

## 5. Equitable Regional Cost Sharing

It is proposed that the regional share of the Demonstration cost be allocated among counties on a population basis. Solid waste generation quantities were also investigated as a basis for determining cost shares, but available statistics from the State Department of Health were considered to be too unreliable on which to base cash outlays.

A precedent for basing cost sharing on population was set in the Netherlands recently, where a regional incineration plan was funded by 23 municipalities on a pro rata basis according to population.[1] Furthermore, population figures are fairly closely correlated with municipal refuse generation quantities and each county stands to benefit from the Demonstration by the amount of its solid waste disposal load.

Population figures by county are shown in the following table. The percent of the regional total is also shown along with the estimated cost per county per year, assuming 10% regional financing.

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[1] Solid Wastes Management, Rotterdam Burns 700,000 Tons of Refuse Yearly, September 1973, p. 68.

## Regional Share of Demonstration Cost

| County | Population[1] | % of Regional Total | Cost Per Year |
|---|---|---|---|
| Alameda | 1,120,800 | 19.4 | $ 44,426 |
| Contra Costa | 587,100 | 10.2 | 23,358 |
| Marin | 206,758 | 3.6 | 8,244 |
| Napa | 79,140 | 1.4 | 3,206 |
| Sacramento | 668,100 | 11.6 | 26,564 |
| San Francisco | 715,674 | 12.4 | 28,396 |
| San Joaquin | 290,208 | 5.0 | 11,450 |
| San Mateo | 556,729 | 9.6 | 21,984 |
| Santa Clara | 1,144,000 | 19.8 | 45,342 |
| Solano | 181,900 | 3.1 | 7,099 |
| Sonoma | 222,600 | 3.9 | 8,931 |
| Total | 5,773,009 | 100.0 | $229,000 |

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[1] State Department of Finance, November 1972.

# IV. CONCEPT OF A FULL-SCALE SYSTEM

## A. PROCESSING STATIONS AND RESOURCE RECOVERY

As public sentiment for resource recovery continues to mount, and as close-in landfill sites around the perimeter of San Francisco Bay become unavailable for further dumping operations, more and more communities will need to develop transfer stations regardless of the ultimate disposition of the waste. The San Francisco transfer station is a prototype of this operation.

Once the need for a transfer station is established, it is increasingly apparent that the recovery of resources from solid wastes is technically feasible, environmentally beneficial and probably economically viable, given a sufficient quantity of refuse. The recycling of solid wastes conserves natural resources and has been shown to conserve energy and to reduce by a factor of 10 to 100 the amount of wastes produced in obtaining raw materials for manufacturing.

A comprehensive system for utilizing municipal solid wastes in the Bay Area would include the recycling of large quantities of newsprint by householder separation and the recovery of metals and glass by mechanical separation in processing stations. The SPUR report projected a need for 16 such transfer stations although the exact number and location of these stations will depend upon many factors.

A typical processing station would service an area up to 25 or 30 miles distant and would process in excess of 2,000 tons per day. This system might include two or three intermediate transfer facilities to achieve higher efficiency in transporting refuse to the processing station.

A multitude of resource recovery systems adapted from mining and lumbering industries are currently under development or installation across the United States. Most of these systems are based on the principal of particle size reduction followed by ballistic separation of the light organic fraction of solid wastes from the heavy, largely inert fraction.

In order to obtain preliminary information on the possible economics of recovering materials from refuse, a marketing study was performed for newspapers, ferrous metal, aluminum, other metals and glass, with the following conclusions:

## Ferrous Metals

Ferrous metal is removed from the waste stream, after shredding or crushing, by natural or electromagnets. If coarsely shredded, it has a current market value of $15.00 a ton for use in copper processing. A new market is developing for steel cans in the scrap steel industry. If finely shredded to a density of 60 pounds per cubic foot, steel cans may sell for $24.00 to $40.00 per ton in the near future.

## Aluminum

Aluminum can be recovered, after shredding and air classification, by one of two processes--a heavy media separation system which "floats" shredded aluminum out of suspension or by a newly developed system that can remove nonmagnetic conductive materials based upon eddy-current phenomena. The latter is still in the developmental stage. Current market value for clean, shredded aluminum is $280.00 per ton.

## Other Metals

Metals that remain after ferrous and aluminum separation include copper, zinc, brass and lead. These metals can also be removed by heavy media or eddy-current separation systems. These metals have a potential market value of $400.00 per ton with foreign buyers.

## Newspaper

There is no effective means for directly recycling newspaper from municipal wastes, unless it is separated by the householder. Newspapers can be collected in racks under trucks during normal route collection or by a monthly separate collection. The market value of newspaper has fluctuated dramatically over the last several years. Due to recent high demand by foreign buyers, the current market price is $25.00 to $40.00 per ton.

Glass, Ceramics and Sand

These materials are removed by vibrating screens and can be used as aggregate or fill material at a market value of $3.00 to $5.00 per ton. If color separation can be achieved, glass can be sold for remelting into new glass containers.

The following table indicates the possible income from the sale of recovered materials. Assuming recovery of newspaper, all metals and glass, a value of $6.58 per ton of refuse can be realized. However, this does not take into consideration the high cost of recovering the material or storage and transportation to the purchase point. The economics of resource recovery will vary according to the market area, whether a transfer station is already available and other factors, all of which must be evaluated for each specific facility being considered.

POSSIBLE INCOME FROM RECOVERY OF MATERIAL FROM RESIDENTIAL REFUSE

| | % Recoverable from Refuse | Market Value/Ton | Value per Ton of Refuse |
|---|---|---|---|
| Newspaper[1] | 10 | $ 25.00 | $ 2.50 |
| Ferrous metal | 5 | 15.00 | 0.75 |
| Aluminum cans | .4 | 280.00 | 1.12 |
| Glass and sand | 7 | 3.00 | 0.21 |
| Other metals | .5 | 400.00 | 2.00 |
| | | | $ 6.58 |

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[1] Newspaper is estimated to be 20% of the residential wastestream. 50% separation is assumed.

A rough estimate of the cost of operating a processing station can be determined from several facilities now in operation. Based on experience in Madison, Wisconsin, an 800 ton per day shredding facility is projected to cost $2.30 per ton, including haul to a disposal site a half a mile away.[1] Operation of the 2,000 ton per day San Francisco transfer station, excluding shredding and ferrous metal recovery, costs $2.75 per ton. This does not include the cost of transportation to the Mountain View landfill. The ferrous recovery system currently in operation is presumably at least a break-even operation. Additional shredding and resource recovery systems for metals and glass are being studied by the San Francisco refuse firms and preliminary results indicate the system could break even or require a small subsidy. Based on these indications, it is estimated that the cost of operating a large-scale processing station, after the net revenue from resource recovery is obtained, should be on the order of $3.00 per ton.

## B. COMPOSTING

Composting technology has been extensively developed in both Europe and the United States. The various systems can be categorized as either enclosed or open. Enclosed systems involve containment of organic wastes in a digester for a few days, during which considerable stabilization can be achieved by mechanical control of environmental factors such as moisture, aeration and carbon:nitrogen ratio. The Fairfield-Hardy digester proposed for the Delaware Reclamation project is an example of this type of system.[2] These systems require less land and achieve faster stabilization than open systems, although a maturation process of several months is often required, the capital investment is high, and the largest unit systems which have been designed only have a capacity of 200-300 tons per day. Enclosed systems may be impractical when considering the composting of the 5-10,000 tons per day of organic wastes produced by the whole Bay Area.

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[1] Final Report on a Milling Project at Madison, Wisconsin, Volume 1, March 1973, p. 97.

[2] Pasquale Canzano, Project Engineer, Delaware Reclamation Project. Personal Communication, October 1973.

Open systems involve the piling of organic wastes into windrows, which are turned and moistened every few days for a period of several weeks. Windrow composting requires a lower capital investment, and the only limit to its capacity is the availability of land on which to pile the windrows. This land requirement is the chief disadvantage of windrow composting in large quantities. If one acre of land is required for every 30 tons per day of organic refuse processed, a total of perhaps 300 acres of land would be needed for the entire Bay Area. This raises the question of where large-scale windrow composting could be performed.

If sufficient land were available, composting could be performed directly adjacent to the processing stations. Alternatively, one or several regional composting operations could be established to receive organic wastes shipped from the various processing stations.

The concept in the SPUR report was to do the composting right on the Delta island where the compost was to be placed. Experience gained during the Demonstration may indicate this is feasible; but problems of leachate containment, disposal of screened material and other factors make such an operation appear inadvisable on the basis of current information.

The cost of composting as reported in the literature varies considerably, some estimates ranging from $2.90/per ton of incoming refuse to $13.00 per ton as shown in the following table.

| SYSTEM | CAPACITY (tons per day) | COST/TON |
|---|---|---|
| John Snell process | 400 | $ 2.90[1] |
| Fairfield-Hardy | 100 | 13.00[1] |
| Fairfield-Hardy | 400 | 8.50[1] |
| Beltsville, Md. (sludge only) | 600 | 3.50[2] |

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[1] Recovery and Utilization of Municipal Solid Waste.

[2] Conservation News, Volume 38, No. 28, Sewage Sludge - Back to the Farm, October 15, 1973.

Based on this data, and considering that preprocessing would be accomplished at transfer stations, it is projected that large scale composting could cost on the order of $5.00 per ton. If regional composting sites are used, requiring long transportation distances from processing stations, a maximum of $3.00 per ton for transportation might have to be added to the cost. Another $1.00 per ton of incoming refuse should be allowed for disposal of residuals.

## C. TRANSPORT TO DELTA AND COMPOST PLACEMENT

Transport of compost to the Delta in a full-scale operation can be accomplished much more efficiently than in the Demonstration due to economies of scale. If composting is performed adjacent to a barge loading operation, the material can be loaded into barges by conveyor. One thousand or two thousand ton capacity self-unloading barges could be designed with sloping sides, a screw conveyor and an elevator. At the island the barges could feed a high belt conveyor which would cross the levee and dump compost onto the island floor. The unloading operation could occur at a single point on the island, or conceivably, the barge could unload at various points around the island as sections of the levee berm were completed.

Scraper vehicles could be used to move compost to the placement location if unloading occurs at a single point on the island. Once placed on an island, compost would need to be compacted by a tracked bulldozer.

Rail haul of compost to the Delta is also a possibility, but would depend on locating the composting site near a rail line. Also rail haul would only be an option in the Southern Delta where the Santa Fe rail line crosses Orwood Tract, Woodward Island and Lower Jones Tract.

The cost to transport and place 1,000 tons of compost per day from a mid-bay location such as Berkeley or San Francisco over a 20-year period is estimated in the following table.

COST OF TRANSPORT AND PLACEMENT ON DELTA ISLAND
OF 1,000 TONS PER DAY OF COMPOST FROM BAY AREA

| Item | Cost Per Ton of Compost[1] |
|---|---|
| Load barges | $ 1.00 |
| Tow barges to Delta (25-hour round trip) | 2.70 |
| Unload barges | .50 |
| Place and compact compost | 3.00 |
| Total | $ 7.20 |

D. IMPACT ON SOLID WASTE DISPOSAL

It is important to consider what percentage of the Bay Area's solid waste disposal load the Bay Delta plan could recover by recycling and land reclamation. Based on figures developed by the Sanitary Engineering Research Laboratory of the University of California,[2] it is estimated that quantities of solid wastes disposed of in the Bay Area can be classified according to the following categories:

| | Tons Per Year Disposed[3] | Percentage of Total |
|---|---|---|
| Residential | 1,500,000 | 35.7 |
| Commercial and Public (including sewage sludge) | 1,800,000 | 42.9 |
| Construction and Demolition | 600,000 | 14.3 |
| Industrial | 300,000 | 7.1 |
| Total | 4,200,000 | 100.0% |

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[1] Includes capital costs amortized over 20 years.

[2] Comprehensive Studies of Solid Waste Management, SERL.

[3] These figures are based on 1966 statistics. Current disposal quantities are greater, although the percentage composition has presumably not changed significantly.

Of this total it is assumed that only the residential and commercial fraction is suitable for processing. If half of all newspapers could be sorted for recycling and if other residential and commercial wastes were to be processed for recovery of metals and glass and composting of the organic remainder, the final disposition of all wastes is estimated as follows:

| | % of Total Wastes |
|---|---|
| Compost (35% moisture) | 40 |
| Recovered metals, glass, paper | 10 |
| Carbon dioxide and water lost to atmosphere | 20 |
| Residual for disposal | 30 |
| Total | 100% |

The quantity remaining for disposal may increase if restrictions are placed on the extent of municipal wastes suitable for composting, or could decrease if some of the residuals, including plastics, rubber, solvents, etc., could be utilized as fuel to partially offset the energy requirements of a recycling system. The heavy demolition debris might also prove to be of beneficial use when the handling of it is coordinated at a regional level.

## E. IMPACT ON LEVEE STABILIZATION

According to the most recent figures from the State Department of Health, 5.7 million tons of solid waste are disposed of in the Bay Area annually.

If 40% of this can be converted to compost, 2.25 million tons of compost could be produced per year. This quantity is sufficient to treat 5.5 miles of levee per year assuming:

- the berm requires 3,000 cubic feet of fill per foot of levee
- compost is 65% solids
- compost solids compact to 33 pounds/cubic foot

This quantity of compost could increase, however, since annual solid waste generation is likely to keep growing and since agricultural wastes, which would roughly double the available supply of organic materials for composting may require disposal in the future.

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APPENDIX

OFFICE OF THE MAYOR
CITY OF BERKELEY
CALIFORNIA

WARREN WIDENER
*Mayor*

September 18, 1973

Members of the Action Committee
Bay Delta Resource Recovery Demonstration Project
c/o Association of Bay Area Governments
Hotel Claremont
Berkeley, CA 94705

Ladies and Gentlemen:

On behalf of the Berkeley City Council, I am pleased to submit our revised Participant Community Proposal as authorized at our regular Council meeting on September 18.

Since your action of September 5, tentatively electing Berkeley as a Demonstration Community, a number of steps toward answering your concerns have been taken, including:

A. On September 11, the City Council authorized me to appoint a special committee of Council members to meet in conjunction with City staff and representatives of the Solid Waste Commission, and with representatives of the Demonstration Project on details of the City's proposal. The appointed Committee members are Councilwoman Hancock, Councilman Kallgren, Councilwoman Hone and myself.

B. Further discussions, including on-site visits, have been held between the Project Consultants and City representatives on the matter of alternative sites.

C. On September 18, the City Council approved the attached amended proposal and authorized me to transmit the document to the Action Committee. The major change in the proposal as approved was the inclusion of a clarifying statement that a three-acre site for composting on city-owned waterfront land was determined to be appropriate.

I trust that the above actions sufficiently resolve all reservations held by the Action Committee, and that the City of Berkeley will receive final approval as the host community for the Project.

Sincerely,

Warren Widener

Warren Widener
Mayor

cc: Berkeley City Council
City Manager
Solid Waste Commission Members

# BAY DELTA RESOURCE RECOVERY DEMONSTRATION PROJECT

## SUMMARY OF

## PARTICIPANT COMMUNITY PROPOSAL

## CITY OF BERKELEY

Planning Department
August 31, 1973
Revised September 18, 1973

PROPOSAL SUMMARY
CITY OF BERKELEY

## BAY DELTA DEMONSTRATION PROJECT

On July 24, 1973 the Berkeley City Council authorized submission of a proposal to the ABAG/Bay Delta Resource Recovery Demonstration Project in support of the City's desire to be selected as a participant community. That action was communicated to the Project consultants by letter from the Berkeley City Manager. Subsequently, the City has been able to further refine some elements of its proposal. This summary proposal, therefore, represents a current description of the City's proposal to the Project as of August 31, 1973.

### Material

The entire amount of daily garbage collected by the City of Berkeley (140-160 tons/day) will be furnished to the Project. This material will be supplemented with additional tonnage by Oakland Scavenger from collections in Albany and Emeryville to achieve a grand total of approximately 200 tons/day. Although no official commitments have been made, it is expected that sewerage sludge in an appropriate amount can be obtained from the East Bay Municipal Utilities District.

### Facilities

A site of approximately three acres for composting functions will be furnished by the City. The City will assume responsibility for the establishment of a building on a site of about one acre adjacent to the composting site for receiving/processing functions.

While no specific site other than the present sanitary landfill* is presently available under City control or management, approximately four sites have been identified as potentially suitable for purposes of the demonstration. (See attached site map.)

Apart from the Demonstration Project, the City has interests in and will pursue steps to acquire land for a solid waste management facility and other municipal uses to replace current sanitary land fill operations on the Berkeley waterfront. Final decisions of site selection cannot be made prior to selection of the participant community by September, 1973. However, a specific determination on site selection and necessary land acquisition will be made during fiscal year 1973-1974. It is fully expected that a site will be determined and steps initiated toward acquisition, if required, well before implementation of the Demonstration Project.

The Berkeley City Council has determined to offer land and buildings necessary for the Demonstration Project cognizant of a potential cost responsibility to the City of over $900,000. This determination was made in recognition of the need to acquire a site for solid waste management operations in the immediate future, irrespective of whether the City is selected as a participant community. In concluding its 1973-1974 budget deliberation on August 28, the City Council took actions to make available approximately $300,000 for Solid Waste Management projects, including site acquisition expenses.

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*A site on the northeast portion of the current landfill [illegible] determined as appropriate for a composting operation during the [illegible] Demonstration Project. (Action by Berkeley City Council, September [illegible] 1973.)

## Processing

The City of Berkeley offers to provide a site of one acre and a building to house receiving and initial processing operations. The City proposes that equipping such a building be a financial responsibility of the Project. Operational responsibility for processing functions could be by the City of Berkeley, by another party under contract to the City, or by the Project. The City proposes that these matters be defined by mutual agreement subsequent to participant community selection.

## Composting

The City proposes that facilities (other than land) and financial responsibility for composting functions rest with the Project. The City is willing to consider entering into a contract with the Project to provide operational responsibility for composting functions if compensated for all attendant costs. The City is agreeable to other parties performing composting functions as desired by the Project, subject only to the specification of appropriate limitations on the City's scope of responsibility where functions interface.

## Transportation to Delta

It is proposed that transportation of composted material to the disposition site be a Project responsibility. The City is willing to consider assuming that responsibility under contract if all associated costs are borne by the Project. Berkeley would arrange for a subcontract for Delta Island Transportation should the Project desire such an arrangement.

The City is willing to cooperate with the Project in the implementation of transportation functions for any mode selected by the Project.

## Monitoring and Evaluation

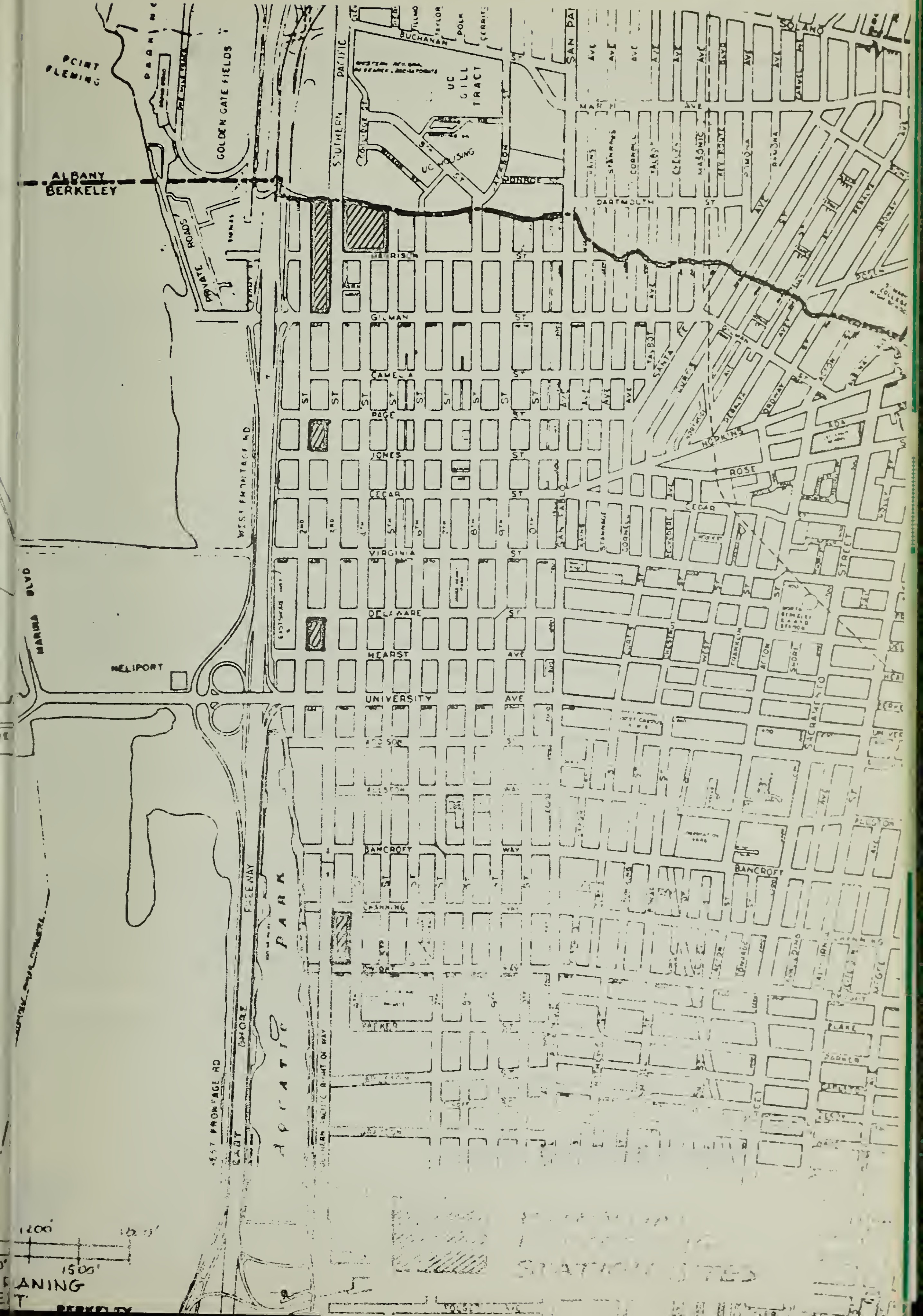
It is proposed that these functions be carried out by a technically competent organization engaged by the Project. It is further proposed that these functions extend to the receiving/initial processing phase as well as the composting phase with specific reference to control of emissions (noise, odor, vibration, windblown matter), economy of operations and quality control

## Project Administration and Management

Overall responsib[illegible] the Project Action Committee and the consultants in a structure determined by the Project. The City of Berkeley is willing to enter into management contract with the Project for those administrative responsibilities deemed mutually desirable

## Community Support

The City of Berkeley [illegible] demonstrated [illegible] support [illegible] implementation of the Demonstration Project. [illegible] lative bod[illegible] interested community organizations both in the formation of the joint powers agency and in the development of this proposal document this support. Berkeley offers an unmatched array of public and private organizational resources in the fields of ecology, environmental management, recycling of waste materials, education, research, and technical expertise through local organizations and institutions. We believe that the importance of such supportive resources should not be underestimated as a factor in the successful outcome of the Demonstration Project.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MARINA BLVD
HELIPORT
EASTSHORE FREEWAY
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1500'
PLANNING
T
BERKELEY
STATION SITES

OAKLAND SCAVENGER COMPANY

2601 PERALTA STREET • OAKLAND, CALIFORNIA 94607
Telephone 465-2911

September 14, 1974

Mr. R. C. Gagley
Director of Services
City of Berkeley
Berkeley, Calif. 94705

Dear Mr. Gagley:

We are writing to you in reference to your inquiry of September 7, 1973, regarding supplementing your refuse supply to provide 200 tons per day to the Bay Delta Resource Recovery Demonstration Project.

We can readily divert 50 or more tons per day to the Berkeley landfill site for this project at no cost to the City. These materials would be from our regular residential route refuse collections from cities adjacent to Berkeley.

Kindly give us adequate advance notice of your requirements.

If you have further questions, please contact Mr. Lou Schmitz of this office.

Very truly yours,

OAKLAND SCAVENGER COMPANY

Joe Biasotti
Vice-President

JB;ym

RECEIVED

OCT 17 1973

ASSOCIATION OF
BAY AREA GOVERNMENTS

October 11, 1973

Mr. Fred Maggiora, Chairman
Action Committee for the Bay Delta
Resource Recovery Demonstration
c/o ABAG
Hotel Claremont
Berkeley, CA 94705

Dear Mr. Maggiora:

Subject: Supplying Sewage Sludge for the Bay Delta Resource Recovery Demonstration

This letter will confirm statements by Mr. Anton, the District's representative to the Action Committee, that the District will furnish and deliver an average of from 5 to 25 tons per day (including weight of solids and water) of digested sludge that has been dewatered to about 25 per cent solids. We understand that the sludge is to be delivered in full truck increments of about 25 tons each during the normal work week to the demonstration composting site which is expected to be located along the Berkeley waterfront. We further understand that the sludge may be needed for the entire three-year Demonstration period starting as early as April, 1975 and ending by April, 1978. Under these conditions, the District will furnish and deliver, upon reasonable notice, dewatered sludge at no cost to the Demonstration.

We are aware of the possible need for the District also to furnish a comparable amount of dewatered sludge to a composting site located in northeast South San Francisco. Although it appears that the District may be able to do this at no additional cost, any commitment on our part will depend on the specific arrangements and contractual agreement with the sludge disposal contractor at the time the sludge is required.

We compliment the Action Committee for its work to date and wish it success in its efforts to secure project financing.

Very truly yours,

John S Harnett

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MEMBER
Board of Supervisors

DIANNE FEINSTEIN

September 4, 1973

Bay Delta Resource Recovery Committee
Association of Bay Area Governments
Hotel Claremont
Berkeley, California 94705

Dear Sirs:

This is to transmit copies of the Board of Supervisors' resolution declaring San Francisco's interest in participating in the Bay Delta Resource Recovery Demonstration.

In addition, under separate cover, Mr. Myron Tatarian, Director of Public Works, is transmitting a letter which provides answers to questions contained in the July 3, 1973 communication from Mr. Russell Faure-Brac.

A meeting was held with Mr. Sutfin and Mr. Lathrop of Southern Pacific on Monday, August 27. Unfortunately, I was not able to be present at the meeting but Chairman Fred Maggiora has informed me that Southern Pacific has indicated willingness to negotiate a lease on the three or four acres in Brisbane directly adjacent to the transfer station.

It is my hope that the resolution from the Board of Supervisors and Mr. Tatarian's letter satisfactorily indicates San Francisco's interest and willingness to participate in the Bay Delta Resource Recovery Demonstration Project.

Sincerely yours,

Dianne Feinstein

SUPERVISOR DIANNE FEINSTEIN

DF/jre
cc: Mr. S. Myron Tatarian
Enc: Board of Supervisors Resolution
August 28, 1973 letter to Mr. Sutfin from Fred Maggiora

FILE NO.________ RESOLUTION NO.________

DECLARING SAN FRANCISCO'S INTEREST IN PARTICIPATING IN THE BAY DELTA RESOURCE RECOVERY DEMONSTRATION

WHEREAS, The Bay Area is about to embark on a unique demonstration program in solid waste management by attempting to implement the so-called SPUR-ABAG study prepared by the San Francisco Planning and Urban Renewal Association in 1971; and

WHEREAS, This program involves the disposal of the Bay Area's solid wastes by using them to reinforce weak and unstable leavees in the Sacramento-San Joaquin Delta; and

WHEREAS, The demonstration will seek to solve a number of environmental problems simultaneously, including the disposal of refuse, sewage sludge and dredger spoils; the recovery of resources for reuse by industry; the reinforcement of levees in the Delta; the improvement of the characteristics of agricultural soil; the reduction of water pollution from Delta island water intrusion; and the reduction of air pollution from windblown peat soil; now therefore, be it

RESOLVED, That this Board of Supervisors does indicate its interest in participating in the demonstration program involving the disposal of 100 tons of composted solid waste material per day for a three-year period, and to obtain data, including costs, to determine the feasibility of the SPUR-ABAG plan for the Bay Region.

CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS

IVED SEP -4 1973

OFFICE OF THE
DIRECTOR OF PUBLIC WORKS

260 CITY HALL
SAN FRANCISCO
CALIFORNIA 94102

September 4, 1973

Bay Delta Resource Recovery
Demonstration Project

Mr. Russell Faure-Brac
Environmental Impact Planning Corporation
319 - 11th Street
San Francisco, California 94103

Dear Mr. Faure-Brac:

Your letter of July 3, 1973 relative to the Bay Delta Resource Recovery Demonstration Project addressed to Supervisor Feinstein has been referred to this department for reply.

The contractual relationships existing between the City and County of San Francisco and the two scavenger companies, the Sanitary Fill Company and the City of Mountain View make definitive answers to the questions posed in your letter extremely difficult. Nevertheless, I will attempt to provide as complete answers as possible under the circumstances, which answers were for the most part obtained from the operators of our collection and disposal systems.

In answer to the specific questions contained on page 3 of your letter:

1. 200 tons per day (1000 tons per week) of residential wastes can be delivered to the Transfer Station and thence to a composting facility (if in close proximity to the Transfer Station) over a 3 year period at no cost to the Project.

2. 20 tons per day (100 tons per week) of digested sewage sludge solids could be delivered to the composting facility over a 3 year period, but the present composition of San Francisco's sewage sludge has a high water content, and perhaps 100 tons of this sludge would have to be delivered to produce the required 20 tons per day of sewage sludge solids.

3. The City of San Francisco does not have three acres of land that could be used for a composting facility. The scavenger companies have indicated that perhaps they could buy or lease the required three acres. They have indicated the possibility of leasing land just south of their Transfer Station. The scavengers would expect compensation for the land, whether purchased or leased.

4. The scavenger companies are actively involved in resource recovery of solid wastes, principally regarding newspapers, corregated paper and ferrous metals. Their plans are to expand the resource recovery facilities to include additional materials.

5. The scavenger companies have expressed an interest in offering a package plan for the supply of refuse and sludge, operation of a composting facility, transporting the compost to the Delta, and in addition, operating the landfill area at the Delta. In effect, the scavengers' offer would be conveyed through the City of San Francisco.

The following comments are offered on the ten considerations included in your letter:

1. No comment.

2. The City of San Francisco, through its scavenger companies, is physically ready now to deliver residential refuse and sludge to the demonstration project. It is not possible to know the time required to negotiate an agreement for the demonstration between all the interested parties.

3. The supply of materials would be dependable, and alternate disposal of the material would be available in the event the composting operation should be halted for a period of time.

4. It would be physically possible to expand the supply of material for the demonstration, but there would be contractual limitations as to the quantity of material that could be withheld from the existing landfill area.

5. A composting plant could be continued to be used as a composting plant after the demonstration was over, assuming that the need for a composting facility existed after the demonstration project had ended.

6. A spirit of cooperation exists between the independent parties that would participate in the demonstration.

7. The composting plant serves one function of resource recovery. The City, through its scavenger companies, is actively involved in other aspects of resources recovery.

8. The San Francisco location would offer a good test of the regionality of the demonstration.

9. The demonstration would possibly extend the life of the current landfill operations, but there could be contractual problems involved under the landfill agreement.

10. There is a high level of interest in the demonstration on the part of the Board of Supervisors, the scavengers companies and, I would assume, on the part of the citizenry at large.

If you wish further information please let me know.

Very truly yours,

S. M. Tatarian
Director of Public Works

MEMBER
Board of Supervisors

DIANNE FEINSTEIN

September 25, 1973

Councilman Fred Maggiora
Chairman, Association of Bay Area Governments
Bay Delta Resource Recovery Project
% Hotel Claremont
Berkeley, California

Dear Mr. Chairman:

The purpose of this letter is to request reconsideration of the September 19th decision to accept Berkeley as the Demonstration City in the Association of Bay Area Governments Bay Delta Resource Recovery Project and also to request reconsideration of the action setting July, 1974 as the target date.

San Francisco had secured a tentative commitment from Southern Pacific to lease four (4) acres of land directly adjacent to the transfer station for the purpose of building a composting facility. Unfortunately, directly prior to the meeting, Southern Pacific indicated that previous master plan commitments forced withdrawal of their offer. Since then, Sunset Scavengers and Golden Gate Disposal has indicated that they would be willing to lease up to five (5) acres of land at $1.00 per year for the purpose of this project. (see attached)

San Francisco is now prepared to proceed immediately as the demonstration City. Because of our ability to provide the necessary land and the fully equipped transfer station which includes grinding and magnetic separation of ferrous metals, San Francisco is ideally suited for selection.

In summary, we request reconsideration of the selection of the demonstration city and also of the action setting the target date.

Thank you and warmest regards.

Sincerely yours,

SUPERVISOR DIANNE FEINSTEIN

DF /bm

*Sunset Scavenger Company*

*From the office*
*of the*
*President*

*Leonard D. Stefanelli*

September 24, 1973

Honorable Dianne Feinstein
San Francisco Board of Supervisors
235 City Hall
Grove and Van Ness Avenue
San Francisco, California 94102

RE: San Francisco Bay-Delta Resource
Recovery Demonstration Project

Dear Supervisor Feinstein:

As per our conversation, I am enclosing the additional information you requested, regarding the many advantages to the above mentioned project, if this system is in fact integrated into the existing San Francisco Solid Waste disposal program.

I will only attempt to outline the more obvious advantages (physically and financially) to the program, if San Francisco is in fact accepted as the participating City.

I would also like to take a brief moment to again remind you that San Francisco is presently operating, and has operated for almost three years, the largest and most comprehensive solid waste system in the United States today, therefore the opinions stated in the memo, are not through speculation, but through a comprehensive knowledge and more than 50 years of working experience, in the field of "Solid Waste Management". Therefore, in my humble opinion, we are extremely qualified to make comments and judgments in these matters.

*Tunnel Avenue and Beatty Road / San Francisco, California 94134 / (415) 467*

In our opinion, the City of San Francisco should be reconsidered as the primary city to participate in the Bay Delta Project for the following reasons:

1 - San Francisco has already in operation, one of the most advanced and largest solid waste processing facilities in the world, receiving almost 2500 tons of waste per day, with a total capacity of some 5000 tons per day, if necessary.

2 - The station is located on the San Francisco-San Mateo County line, therefore, from a geographical point of view is ideally located to incorporate a truly "regional" system of refuse disposal, is deemed to be feasible.

3- Sunset Scavenger Company and Golden Gate Disposal Company have in their possession five acres (or more ) of land that is adjacent to deep water bay channel in San Mateo County, but within the immediate area of the Transfer Station, that can be utilized for the actual "composting phase" of the project. Cost for the land, under a lease basis would be minimal during the term of the development period.

4 - The San Francisco System already has in operation, a proven (in house) waste grinder and magnetic separator (ferrous metal extractor) that has a capacity of more than 100 tons per hour.

Total investment (private capital)in just the Transfer Station, Grinder, Magnetic Separator, related equipment and land, exceeds three million dollars.

5 - San Francisco receives and processes more than 2500 tons of mixed waste per day, of which at least 1100 tons can be considered or classified " residential". We also have the ability to "sort" this class of refuse from the balance of the material received.

Therefore, we have more than enough material and the ability to supply the "desirable waste" more suitable for this type of project than any other City being considered.

7 - There is more than sufficient area adjacent and near the existing transfer facilities for construction of the building and equipment needed for the secondary processing facilities, and will be made available for minimal costs for the duration of the project.

8 - We have received a CONTRACT GRANT from the Environmental Protection Agency (EPA) to do the system design work on a secondary resource recovery phase, that would re-grind the refuse into a finer density, a size desirable for air classificatio, thus providing a material compatible to the proposed project.

9 - Because of the fact that the existing solid waste processing facilities are already in operation, and "Phase 1" of the resource recovery system is also in operation, and "Phase 11" was re-considered and accepted as the participating City for thi program, the project would in fact be implemented and proven almost two years sooner than any other city considered, once th necessary financing had been arranged.

Although there are many other reasons that could be cited as to why Sar Francisco is,in our opinion, "the best City for this project", but the most important, is the fact, that it is an on-going system . Proven, with almost three years of uninterrupted operation, and has almost 55% of the required equipment and facilities needed for the Bay-Delta Project, therefore, to duplicate this system eleswhere, would only "duplicate" the expenditures required, and in some cases, on unproven equipment and design.

As a final statement of fact, most people do not understand that a good "collection" system of solid waste is only as good as the "disposal" syster

In simple terms, it means that if you cannot "dump" the refuse you hav already collected in the collection vehicles, you can not continue to collec any additional refuse, therefore, a breakdown in refuse collection will occu, and the material will stay upon the premises of the people being served.

This problem can and will certainly occur if there is a failure in any of he equipment being considered for this project, and most certainly, there will e other shut downs for modifications, changes in operating proceedures, etc.

In either case, I cannot help but notice in the plans, that there have b en no provisions for standby equipment, or suitable storage areas for untreatec waste, if there should be a stoppage of any kind in the system, and this fa tein

astrous effect on the "collection" aspects of any
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importance of this one asset alone, which will not
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I personally have some reservations about certain
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n existence and built into San Francisco's world famous
ystem, the advantages for all the people of the nation
numerous to mention.

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We urge that the issues and reasons as set forth in this memo be re-submitte to the Bay Delta Action Committee, so that the City of San Francisco may be re-considered for this important demonstration project, as we sincerely feel that because of the facts outlined in this memo, San Francisco is obviously the most prominent, eligible and best suited City to prove the feasibility of this program.

Sincerely yours,

SUNSET SCAVENGER COMPANY

LEONARD STEFANELLI
PRESIDENT

LS/mm

Also representing:

GOLDEN GATE DISPOSAL COMPANY
SANITARY FILL COMPANY
SOLID WASTE ENGINEERING AND TRANSFER SY

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alone, could have a disastrous effect on the "collection" aspects of any City who was participating in the project, except the City of San Francisco because these "safe guards" are already incorporated in our existing system.

In simple terms, because of these considerations already implemented in our system, there is no need for concern regarding the work or system stoppage for any reason. This fact may or may not mean anything to most people, but it is one great responsibility that the engineers and project managers will not have to concern themselves with, if there is a shutdown for any reason, and I can not emphasize the importance of this one asset alone, which will not be available under the present plans.

As I stated to you, I personally have some reservations about certain areas of the proposed programs, but this concern is more than offset when I visualize how much knowledge and experience will be developed through the research and development phases of the program, and coupled with the experienc and knowledge already in existence and built into San Francisco's world famous operating solid waste system, the advantages for all the people of the nation becomes obvious and to numerous to mention.

We urge that the issues and reasons as set forth in this memo be re-submitte to the Bay Delta Action Committee, so that the City of San Francisco may be re-considered for this important demonstration project, as we sincerely feel that because of the facts outlined in this memo, San Francisco is obviously the most prominent, eligible and best suited City to prove the feasibility of this program.

Sincerely yours,

SUNSET SCAVENGER COMPANY

LEONARD STEFANELLI
PRESIDENT

LS/mm

Also representing:

GOLDEN GATE DISPOSAL COMPANY
SANITARY FILL COMPANY
SOLID WASTE ENGINEERING AND TRANSFER SY

SANITARY FILL COMPANY
FOOT OF TUNNEL AVENUE
SAN FRANCISCO, CALIFORNIA 94124

October 1, 1973

The Honorable Dianne Feinstein, Supervisor
San Francisco Board of Supervisors
Room 235 - City Hall
San Francisco, California 94102

Dear Mrs. Feinstein:

I am writing this letter in response to the request of the Association of Bay Area Government Action Committee and their consultants, Environmental Impact Planning Corporation.

Sanitary Fill Company is prepared to lease five or more acres for one dollar ($1.00) per year, at Sierra Point, City of South San Francisco. This property is adjacent to a shipping channel used by the American Bridge Division of United States Steel. Access to this property is on easement, granted by the California Division of Highway and Southern Pacific Railroad. The property is located east of the Bayshore Freeway, with offshore prevailing wind, and is ideally located for the proposed demonstration composting project.

Sanitary Fill Company is also prepared to supply rough shredded refuse from the L.A. Transfer Recovery System, and sewage sludge in the amount needed by the demonstration, delivered to Sierra Point site at no cost to the demonstration.

If desired, Sanitary Fill Company and its associates are prepared to supply composted waste in the quality specified by the consultants, delivered on a barge at a price to be negotiated.

Sanitary Fill Company is also prepared to supply, to the demonstration, if required, a fine shredded refuse, similar to that produced by the Combustion Power Company, located in Palo Alto. The price for this product will be based upon the additional cost of the fine shredding, and air classifying of the waste if Sanitary Fill Company or its Associates are not processing the waste for the recovery of the aluminum, glass and other non-ferrous metals. If we find that the Recovery System is profitable, we will supply this fine shredded, air classified waste at no cost.

We are now conducting an Economic Feasibility Study for this process he conjunction of the United States Environmental Protection Agency. ill have an answer to the feasibility of this process in the next four months.

Because of the size of Sanitary Fill's operations and the background it waste processing, we feel that we can offer economics to the program annot be duplicated by anyone else in the Bay Area.

I hope this offer meets with your approval.

Sincerely yours,

SANITARY FILL COMPANY

LEONARD STEFANELLI
VICE PRESIDENT

1

hairman of Action Committee,
Fred Maggoria
'ayne Trewhitt
hn Moscone

ZUCKERMAN
MANDEVILLE, Inc.

PRODUCERS OF FINE AGRICULTURAL PRODUCTS
FROM THE SAN JOAQUIN DELTA

Post Office Box 487 • Stockton, California 95201 • Telephone (209) 465-7213

August 15, 1973

Mr. Fred Maggiora, Chirman
ABAG
Hotel Claremont
Berkeley, California 94705

Dear Mr. Maggiora:

Thank you for your letter of July 31, 1973. I will attempt to answer your questions and number them according to your letter.

1. Personal Liability - We will require a $300,000 minimum with a $1,000,000 (blanket) for the agency leasing the land or any of its contractors.
2. Road Repair - Will be roughly $1,000 per mile per year - distance to be measured from Mandeville bridge to site. It could vary from this figure either way, depending on severity of winter rains and number of trucks using roads.
3. We could contribute to experimental farming of area under supervision of UC Extension Service and would only charge out of pocket costs, such as direct labor, seed, fertilizer, fuel and repair parts.
4. Map is enclosed showing various sites that could be used for demonstration. I have picked 5 sites:
    - a. #3. and #5. could be used best for barge unloading.
    - b. #1. would be most convenient for truck unloading, ease of transportation, inspection, and road maintenance.
5. We would make the site available for a use fee of $50. per acre per year. We would also want an option to be the first recipient of any future materials should the project prove to be a success and the program expanded.

Sincerely yours,

ZUCKERMAN-MANDEVILLE, INC.

By Alfred R Zuckerman
Alfred R. Zuckerman, President

ARZ:ddc

Enclosure

## BAY DELTA RESOURCE RECOVERY DEMONSTRATION PROJECT

This is a Joint Exercise of Powers Agreement entered into by various Public ecies of the San Francisco Bay Delta area under the provisions of the Joint ercise of Powers Act (Calif. Government Code Sec. 6500-6515).

## PURPOSE

Public Agencies entering into this Agreement are supporting a demonstration oram for the disposal of solid wastes by using the organic portions of them r land reclamation in the Sacramento-San Joaquin Delta area. This is a pilot oect to test the feasibility of one of the more promising options for recovery d beneficial use of the resources contained in solid wastes. It is also an ini-a step in the development of regional management for solid wastes and resources very. This demonstration project relates to the legislative mandate contained he Nejedly-Z'Berg-Dills Solid Waste Management and Resources Recovery Act of 7.

Stage 1 of this pilot project is supported by an Environmental Protection ecy grant of $61,800 to the Association of Bay Area Governments and local nibution of $45,000 from public and other participating agencies. Local nibutions are allocated as of August 15, 1973 as follows: Environmental Pro-cion Agency grant local match, $20,600; Environmental Impact Planning Corpo-ton Consultant Contract, $12,000; uncommitted, on hand, $10,900; uncommitted, cnt receivable $1,500. The scope of Stage 1 includes design of management pcts of the pilot project, development of financing and cost allocation plans, nideration of environmental evaluations and organization of an intergovernmental rcture to manage this solid waste demonstration program.

Concerned public and other participating agencies have been proceeding with the charges of Stage 1 through an "ad hoc" Action Committee. It is now concluded that Stage 1 can be completed best by these agencies through a formal joint exercise of powers agreement. This will establish an initial structure which can solicit and encourage federal and state grant financial assistance to the project. It will give a formal beginning to the pilot project without requiring the expenditure of any additional funds or commitments by public and participating agencies.

## TERMS AND CONDITIONS

1. Definitions

A: Project

All elements of Stage 1 of the Bay Delta Resource Recovery Demonstration Project as delineated in the Grant Application of ABAG to the Environmental Protection Agency including but not limited to design of management aspects of the pilot project, development of financing and cost allocation plans, consideration of environmental evaluations, organization of an intergovernmental structure to manage this solid waste demonstration program.

B. Bay Delta Resource Recovery Demonstration Board (hereafter "Board"):

The agency established by this Agreement shall be known as the Bay Delta Resources Recovery Demonstration Board (hereinafter "Board"). Each public agency executing this agreement shall appoint one member (and alternate) to this Board. Each participating agency shall appoint one member (and alternate) to this Board.

C. Public Agency:

Any agency empowered to execute a joint exercise of powers agreement and as defined in Calif. Government Code Sec. 6500.

D. Donor Public Agency:

Any public agency which supplies raw material for the demonstration project.

E. Participating Agency:

Any semi-public agency not included within the definition of Calif. Government Code Sec. 6500 and any private agency or association invited by a two-thirds vote of the Board to participate in the Project.

ost Estimate and Prorated Shares:

The estimated total cost of the Project is $106,800. The Environmental Protection Agency has made a grant of $61,800 to ABAG for the Project. The local contribution of the public and participating agencies is an estimated $45,000. The contribution of each of the counties, cities with population in excess of 50,000, special districts and participating agencies is $3,000 in cash. The contribution of each of the cities with population less than 50,000 is $1,500 in cash.

Local contributions are allocated as of August 15, 1973 as follows: Environmental Protection Agency grant local match, $20,600; Environmental Impact Planning Corporation Consultant Contract, $12,000; uncommitted, on hand, $10,900; uncommitted, account receivable, $1,500.

The contributions listed above represent the maximum financial commitments to date of public and participating agencies to the Project under this Agreement. Under no circumstances shall the debts, liabilities or obligations of the Board be the debts, liabilities or obligations of any of the parties to this Agreement, and each party's obligation hereunder is expressly limited to the contribution heretofore made to the Project.

3. Bay Delta Resource Recovery Demonstration Board: Its Power, Authority, Responsibilities and Duties:

The Board is established to administer, direct and terminate the Project. The Board shall administer and account for all funds. The Board shall establish its own procedures and do all things necessary to the purpose of this agreement. The Board may make and enter into contracts; employ agents and employees; acquire, hold or dispose of property; incur debts, liabilities or obligations and sue and be sued in its own name.

The Board may establish an Executive Committee consisting of the Board member representing a donor public agency for the Project and five additional Board members. The Executive Committee may be authorized to exercise any powers possessed by the Board. Any action of the Executive Committee may be amended or repealed by a majority vote of all Board members.

## The Program Advisory Committee

The State and County Solid Waste Management Plans and Resources Recovery Programs mandated by the Solid Waste Management and Resources Recovery Act of 1972 must consider and develop demonstration projects on the recovery of useful resources from solid wastes. The legislation encourages regional solid waste management planning.

The Board, recognizing these goals, shall appoint a Program Advisory Committee composed of the following membership: one representative nominated by the State Solid Waste Management Board; one representative nominated by the State Department of Public Health; one representative nominated by the Boards of Supervisors from each of the following counties: Alameda, Contra Costa, Marin, Napa, San Francisco, San Joaquin, Santa Clara, San Mateo, Solano, and Sonoma. County representatives should be selected from among those involved with the County Solid Waste Management Program. Additional members may be added from time to time by a majority vote of the Board.

The Program Advisory Committee shall review the elements of Stage 1 and make recommendations and report to the Board.

5. Restrictions Upon Exercise of Power of Board:

This Agreement is entered into under the provisions of Title 7.3 and Article 1 of Chapter 5, Division 7, Title 1 of the California Government Code. In accordance with section 6509 thereof, the powers to be exercised hereunder shall be subject to the restrictions upon the manner of exercising the powers as are imposed upon the City of Oakland in the exercise of similar powers.

6. Staff:

The Association of Bay Area Governments shall provide the support staff assistance for the Project through its employees and retained consultants, and shall maintain its responsibility under the Environmental Protection Agency Grant to the Association of Bay Area Governments for the Project.

7. Funds, Audit and Accounting Services:

The Treasurer of the County of Alameda, pursuant to Government Code Section 6505.5, is designated to be the depository and to have custody of all project funds. He shall perform the duties specified in Government Code Section 6505.5.

The Auditor of the County of Alameda shall perform the functions of auditor or controller. He shall perform the duties specified in Government Code Section 6505.

There shall be strict accountability of all funds and report of all receipts and disbursements.

## 8. Termination

This Agreement shall remain in effect for the period of time the Board determines is necessary to complete programs specified under this Agreement, unless terminated prior thereto by a majority vote of the Board. Any individual public agency may withdraw, but this Agreement shall not be terminated by such withdrawal.

Upon termination, any funds or other property of the Project remaining after payment of all obligations, shall be distributed to the public and participating agencies in proportion to their respective contributions.

## 9. Reservation to Amend or Supplement Agreement:

The public agencies reserve the right to amend or supplement this Agreement within the scope thereof at any time for any purpose in accordance with the provisions of applicable law.

## 10. Effective Date of Agreement:

This Agreement may be executed in counterparts and shall be effective upon counterpart execution by ten (10) public agencies.

EXECUTED:

AGENCY: DATE:

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Vol. II

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# SOLID WASTE MANAGEMENT IMPLEMENTATION PROJECT

SAN FRANCISCO BAY AREA

## Volume II

## Environmental Evaluation for the Bay Delta Resource Recovery Demonstration Project

ABAG
ASSOCIATION
OF BAY AREA
GOVERNMENTS

# BAY AREA SOLID WASTE MANAGEMENT IMPLEMENTATION PROJECT

VOLUME II

## ENVIRONMENTAL EVALUATION FOR THE BAY DELTA RESOURCE RECOVERY DEMONSTRATION PROJECT

A Report Prepared for the Action Committee for
the Bay Delta Resource Recovery Demonstration
and the Association of Bay Area Governments

December 1973 by

ENVIRONMENTAL IMPACT
PLANNING CORPORATION
SAN FRANCISCO, CALIF.

In association with Frank Stead

ABAG
ASSOCIATION
OF BAY AREA
GOVERNMENTS

preparation of this report was financed in part through a
lid Waste Demonstration and Resource Recovery System Grant
the Environmental Protection Agency, under the provisions
of Section 204 of the Solid Waste Disposal Act as amended.

Printed on 100% recycled paper.

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| **BIBLIOGRAPHIC DATA SHEET** | 1. Report No.<br>ABAG-EPA-S-802471 | 2. | 3. Recipient's Accession No. |

4. Title and Subtitle

BAY AREA SOLID WASTE MANAGEMENT IMPLEMENTATION PROJECT - VOLUME II - ENVIRONMENTAL EVALUATION FOR THE BAY DELTA RESOURCE RECOVERY DEMONSTRATION

5. Report Date

6. December 1973

7. Author(s) ENVIRONMENTAL IMPACT PLANNING CORPORATION in association with FRANK STEAD

8. Performing Organization Rept. No.

9. Performing Organization Name and Address

Association of Bay Area Governments
Hotel Claremont
Berkeley, California 94705

10. Project/Task/Work Unit No. Bay Delta Plan - Phase I

11. Contract/Grant No. EPA - S-802471

12. Sponsoring Organization Name and Address

Environmental Protection Agency
Washington, D. C. 20460

13. Type of Report & Period Covered (Summary, Final, Technical, etc.)

14.

15. Supplementary Notes

16. Abstracts This document is Volume II of a three-part report to ABAG. This report documents the planning conducted for the Bay Delta Resource Recovery Demonstration project. This proposed project would demonstrate recovery of resources from urban wastes and the use of composted refuse for island reclamation in the Sacramento-San Joaquin Delta. The report presents original research on the use of compost as a levee strengthening material and documents the planning for an intergovernmental structure to manage the demonstration, and serve as a first step towards eventual regional management of solid wastes. The report is published in three volumes, as follows:

Vol. I: Project Report
Vol. II: Environmental Evaluation for the Bay Delta Resource Recovery Demonstration Project
Vol. III: Technical Report on Levee Stabilization and Composting

17. Key Words and Document Analysis. 17a. Descriptors

17b. Identifiers/Open-Ended Terms

Regional Solid Waste Management
Bay Delta Resource Recovery Demonstration

17c. COSATI Field/Group

|  |  |  |
|---|---|---|
| 18. Availability Statement<br>from the Association of Bay Area Governments, Hotel Claremont Berkeley, California 94705 (handling charge) | 19. Security Class (This Report)<br>UNCLASSIFIED | 21. No. of Pages |
|  | 20. Security Class (This Page<br>UNCLASSIFIED | 22. Price |

FORM NTIS-35 (REV. 3-72) USCOMM-DC 14952-P72

eip
Environmental Impact
Planning Corporation

319 Eleventh Street
San Francisco
California 94103
(415) 626 9034

December 14, 1973

Mr. Revan A. F. Tranter
Executive Director
Association of Bay Area Governments
Claremont Hotel
Berkeley, California 94705

Dear Mr. Tranter:

In the fall of 1972 a group of local agencies in the San Francisco Bay Area joined together in an attempt to initiate a Demonstration project to test the feasibility of using composted organic solid wastes in the low-lying islands of the Sacramento-San Joaquin Delta for levee stabilization, land building and agricultural purposes. These local agencies, calling themselves the Bay Delta Resource Recovery Action Committee, also sought to develop the intergovernmental institution necessary to manage this Demonstration project and perhaps to become the regional agency charged with solid waste management. This report documents the efforts of these local entities, acting voluntarily, to attempt to improve the technical and governmental mechanisms operating in the field of solid waste management today.

The report is presented in three volumes. Volume 1 describes the preliminary system design for the Demonstration project and looks at the concept of Bay-area wide implementation of the plan. It also details the possible institutional mechanisms necessary to implement the plan. Volume 2 is an environmental evaluation of the Demonstration project and is written in the format of an Environmental Impact Report. Volume 3 contains two technical reports upon which the preliminary system design was based. Part A is a study of the structural characteristics of compost and an evaluation of the feasibility of using compost as a levee strengthening material. This report, prepared by Drs. Duncan and Seed of the Engineering Department of the University of California, Berkeley, represents original research on this subject. Part B documents the preliminary compost experiment conducted by Dr. Samuel Hart at Davis, California, and includes recommended composting specifications for the Demonstration.

The consultants wish to thank the members of the Action Committee and its chairman, Councilman Fred Maggiora, for making this report possible. We would also like to thank the U.S. Army Corps of Engineers (San Francisco and Sacramento Districts), the

California Department of Water Resources, the Central Valley Regional Water Quality Control Board, and the California Water Resources Control Board for their valuable contributions. Further, we would like to thank the Sierra Club, the League of Women Voters and the San Francisco Planning and Urban Renewal Association, as well as the many public and private organizations and individuals who participated in this study.

Yours very truly,

and Frank M. Stead

Hans A. Feibusch, P.E.
Frank M. Stead

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# I. INTRODUCTION

The Bay Delta Resource Recovery Demonstration Project is an outgrowth of the 1971 SPUR report entitled, "A Solid Wastes Management System for the Bay Region." That report called for regional management of solid wastes, maximum recovery of resources from the solid waste stream and a proposal to use the organic portion of municipal refuse for island reclamation in the Sacramento-San Joaquin Delta. A pilot scale demonstration project was recommended to test this proposal. Subsequently, an Action Committee was formed under the sponsorship of ABAG (Association of Bay Area Governments) to obtain funding to conduct preliminary planning for the Demonstration. In February 1973 an EPA grant matched by local funding was obtained to conduct this planning study.

This report is an environmental evaluation of the preliminary design for the Demonstration that was developed in the planning study. Since a formal agency has not yet been established to sponsor the project and funding has not yet been obtained for final engineering design, this report is not presented as a legal environmental impact report. However, it follows the state CEQA guidelines for environmental impact reports and can serve as the basis for an EIR once the project reaches a final state of definition.

The Demonstration is temporary and would be conducted on a small scale--approximately 1,800 feet of levee would be treated over a two-year period. The project is designed to monitor the effects of land reclamation with composted refuse and sludge so that environmental questions can be answered before program implementation on a full-scale basis. Therefore, this report primarily addresses the specific impacts of the Demonstration. However, secondary impacts could result from activities stimulated by the successful completion of this project. These secondary impacts are discussed in Sections IX and XI.

The Demonstration would be sited at three primary locations--Berkeley, Sierra Point in South San Francisco and Mandeville Island in San Joaquin County. This report evaluates activities in all three locations.

## II. SUMMARY

he Bay Delta Resource Recovery Demonstration is a two-ear project designed to test resource recovery from unicipal solid wastes and the use of the recovered and rocessed organic fraction for land reclamation in the acramento-San Joaquin Delta.

efuse in Berkeley and San Francisco would be processed o recover metals and possible glass, and organic wastes ould be composted in each city to produce a relatively table humus product. About 100 tons per day of compost ould be produced at each site and barged weekly to andeville Island in the central Delta.

ompost would be placed against an 1,800-foot section of evee in a berm extending 500 feet inland. The berm ould buttress the levee and provide a new soil surface o be used for agricultural production. The Demonstration ould take place on a 20-acre portion of 5,500-acre andeville Island. Extensive monitoring would be conucted to determine the effects on levee stability, water uality, air quality, agricultural productivity and the iotic environment.

e Delta is one of the most valuable resource areas of alifornia, comprising 500,000 acres of prime agricultural and on numerous, scattered islands. The 1,100 miles of arrow sloughs and deepwater channels are valued for ecreation, commercial shipping, fishery resources and as omestic and industrial water sources for major portions the state. The Delta islands are protected by levees hich are subsiding at rates up to five inches per year d require constant maintenance. Since reclamation was egun around the turn of the century, over 100 levee reaks have occurred, some resulting in irretrievable oss of land areas such as Frank's Tract, Big Break and e west end of Sherman Island. If measures are not taken o strengthen these levees, the rest of the Delta similarly could be lost in the decades ahead. In addition to loss of land, flooded, unreclaimed islands create vast adverse effects upon the Delta environment, including greater saltwater intrusion from San Francisco Bay degrading the water quality in the Delta.

Solid wastes, including sewage sludge in the Bay Area, are in most cases unprocessed and dumped in landfills around the perimeter of the Bay. This results in a loss of recoverable resources and often a removal of wildlife habitat and impairment to the quality of surrounding waters.

The Demonstration proposes to test a concept that, if implemented on a large scale, would contribute to the solution of both the solid waste disposal and Delta land subsidence problems. There are potential adverse environmental effects of this concept, however, which would be investigated in the Demonstration.

The environmental evaluation conducted in this study indicates several areas of environmental concern. One of these is levee cracking and possible levee breachment due to the weight of the compost berm. Measures are offered to mitigate this effect, including a drainage system beneath the berm and field observations of pore pressures, settlements and horizontal movements. Another area of concern is the quality of the compost leachate at the composting sites and at the island. While leachates from compost are expected to be much less polluting than from raw refuse, the disposition of compost will be in a delicate estuarine environment rather than a sealed landfill.

Because compost has never been used as an engineering material, and because little research has been conducted on the quality of compost leachates, these preliminary investigations can only point to problem areas. Field research and laboratory analysis as proposed in this Demonstration will be required to establish definitive answers to these questions.

It is expected that the environmental impacts of the Demonstration itself will be minimal due to its limited scale and the extensive concurrent monitoring programs that would be conducted.

## III. PROJECT DESCRIPTION

### A. LOCATION

The Demonstration involves the processing of solid wastes in two urban areas, the transport of compost by barge to the Sacramento-San Joaquin Delta, and the reinforcement of a test section of levee on a Delta island. The project location is shown at a state and regional scale in Figures 1 and 2.

In Berkeley, a transfer station would be built in the industrial area of town just east of Interstate 80. The exact location of the site has not yet been determined by the city; however, the area being considered is shown in Figure 3. Shredded refuse from this facility would be delivered to a composting site at the Berkeley landfill. The landfill is a 40-acre site owned by the City of Berkeley and operated by a private company under contract. The specific composting site is a four-acre section of filled land at the northeast corner, approximately 12 feet above mean high tide in elevation. The coordinates of this site are 122° 19' 03" west and 37° 52' 28" north.

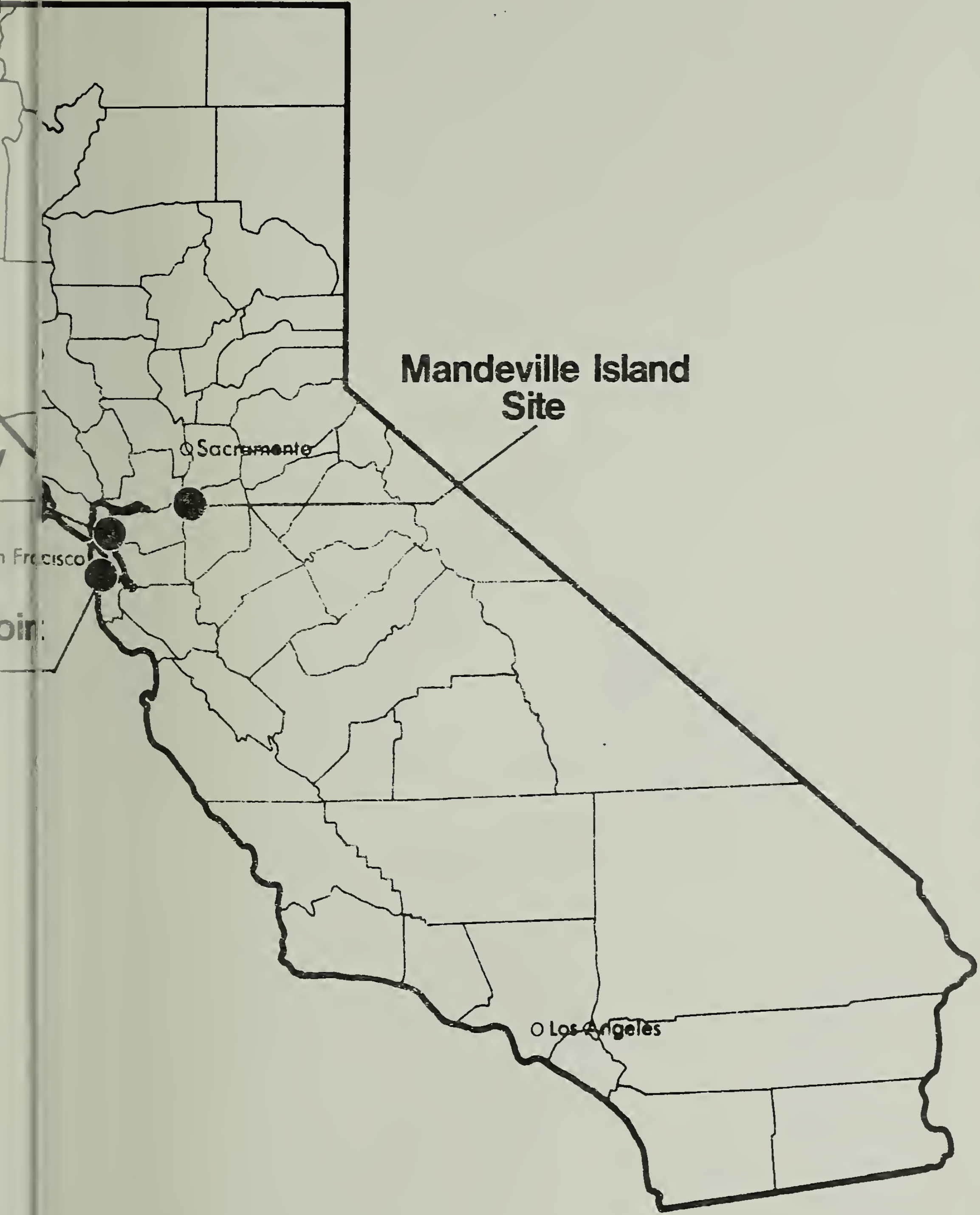
In San Francisco, refuse would be processed at the existing transfer station located west of the Bayshore Freeway on the San Francisco-San Mateo county line (Figure 4). This facility, owned and operated by Solid Waste Engineering and Transfer Systems (SWETS), was built in 1970 to process San Francisco refuse for transfer to a sanitary landfill in Mountain View. Processed refuse for the Demonstration would be delivered from this facility to a composting site on a 25-acre tract of land at Sierra Point. About five acres would be needed for the composting operations. This land, owned by the Sanitary Fill Company, is within the city limits of South San Francisco at coordinates 122° 23' 02" west and 37° 40' 27" north. The property is located east of the Bayshore Freeway and is bounded on the north by the Brisbane-South San Francisco city line. Situated about 10 feet above mean high tide, the site is adjacent to a shipping channel used by the American Bridge Division of U.S. Steel. Access to the property is by an easement granted by the California Division of Highways and Southern Pacific Railroad.

Compost produced at each site would be loaded into a barge docked in the adjacent waterway and transported through San Francisco, San Pablo and Suisun bays, up the San Joaquin River and finally delivered to the southeastern end of Mandeville Island. Centrally located in the Sacramento-San Joaquin Delta, Mandeville Island is bounded on the west by Frank's Tract and Quimby Island, on the south by Bacon Island, on the north by Venice Island, and on the east by Medford Island and McDonald Tract (see Figure 5). Surrounding waterways are Old River, the San Joaquin River, Middle River and Connection Slough. The test site for the Demonstration is a 20-acre parcel of land at coordinates 121° 31' 08" west and 38° 00' 06" north. The site fronts along 2,000 feet of levee and extends inland about 500 feet from the levee crown.

## B. OBJECTIVES

The major objective of the Demonstration is to determine the feasibility of a regional solid waste management program that would recover resources from urban wastes and simultaneously reinforce levees and improve agricultural land in the Sacramento-San Joaquin Delta. Specific project objectives are:

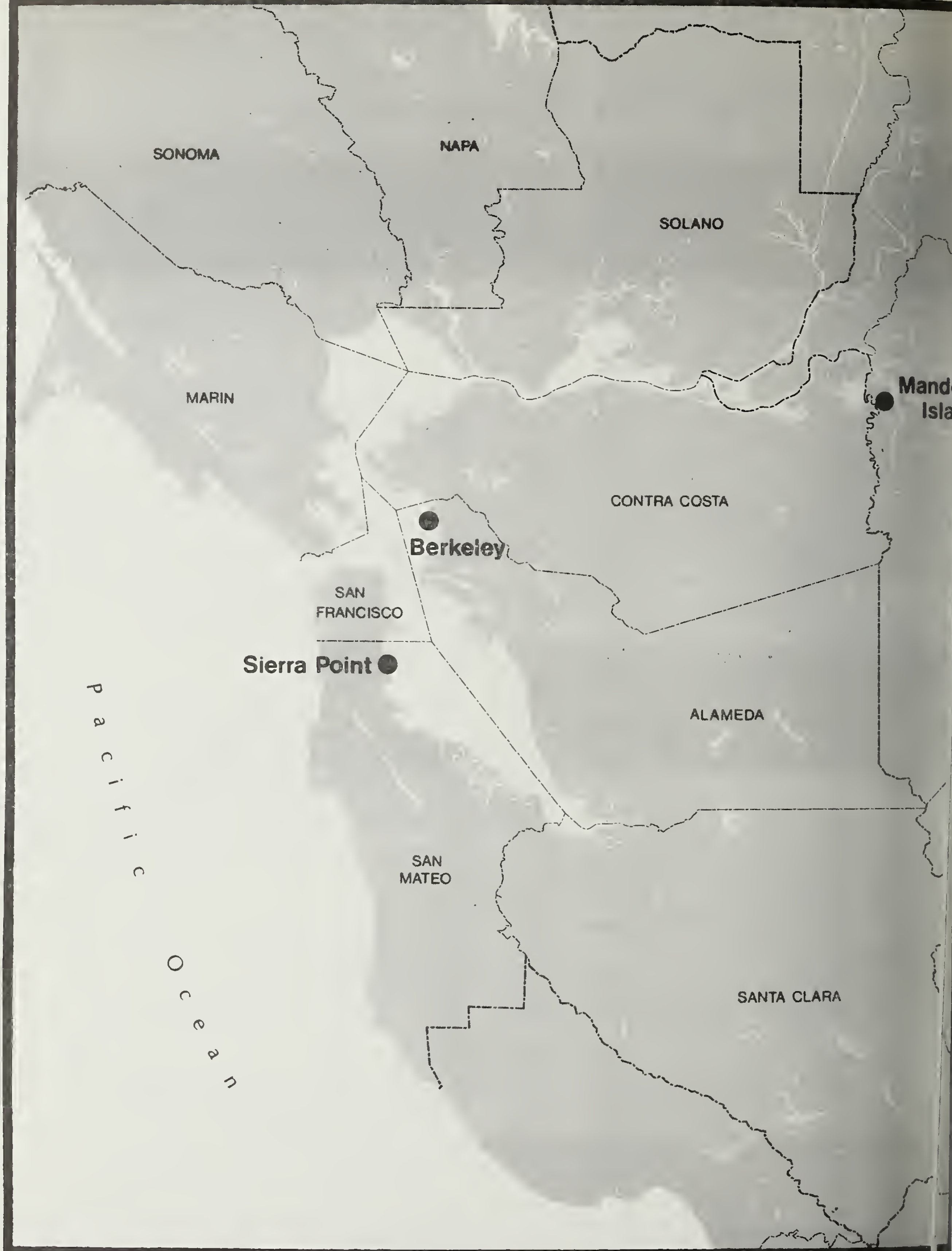
1. Demonstrate regional cooperation in conducting a solid waste project.
2. Demonstrate the technical and economic feasibility of recovery of resources from solid wastes.
3. Determine the engineering feasibility of levee reinforcement with composted urban refuse.
4. Demonstrate the agricultural worth of new soil built from composted refuse.
5. Determine the environmental effects, especially on air and water pollution, of placing compost on a Delta island.



**lifornia Location** **Figure 1**

D lta Resource Recovery Demonstration Project

/ ABAG



**Regional Location** **Figure**

**Bay Delta Resource Recovery Demonstration Project**

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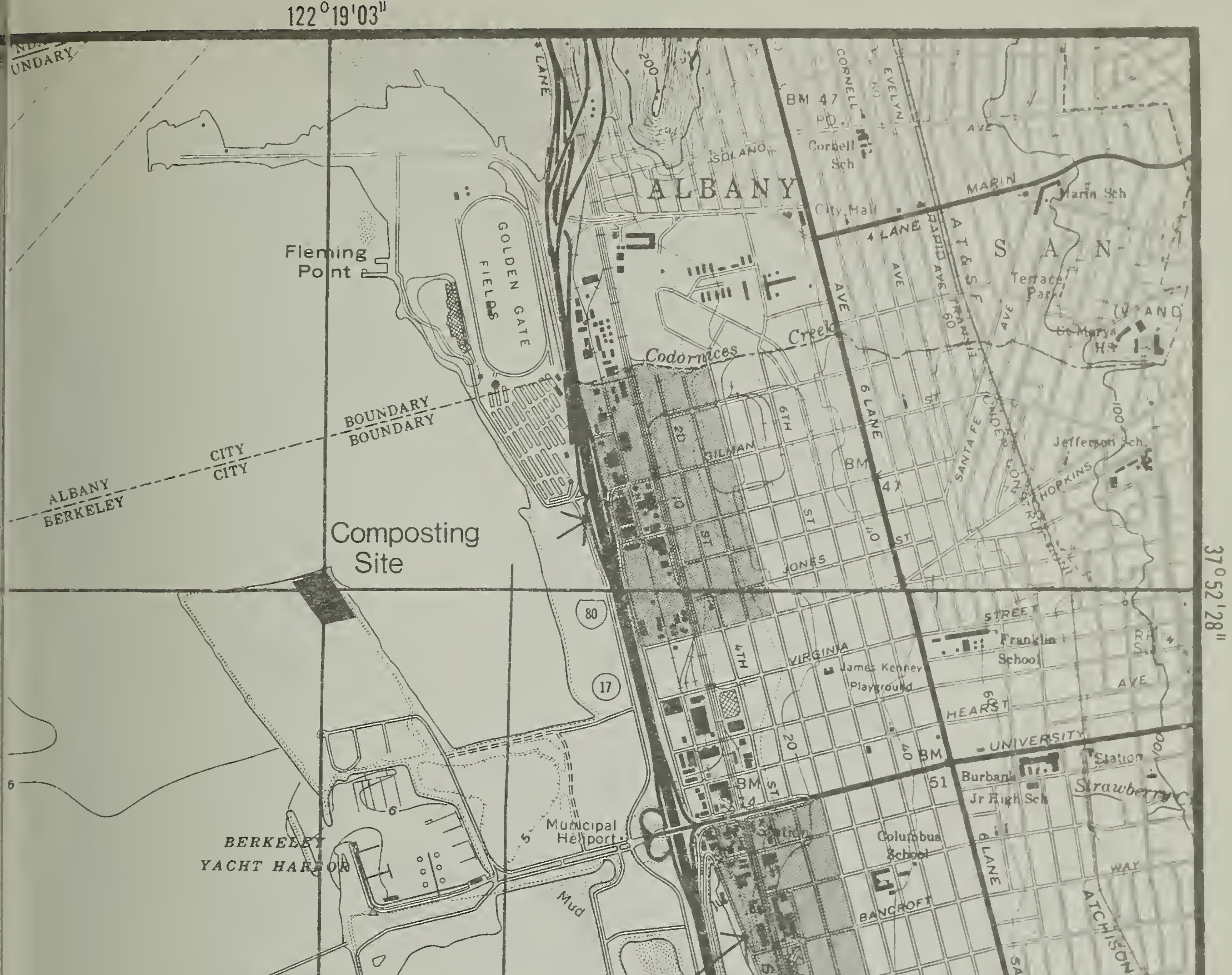


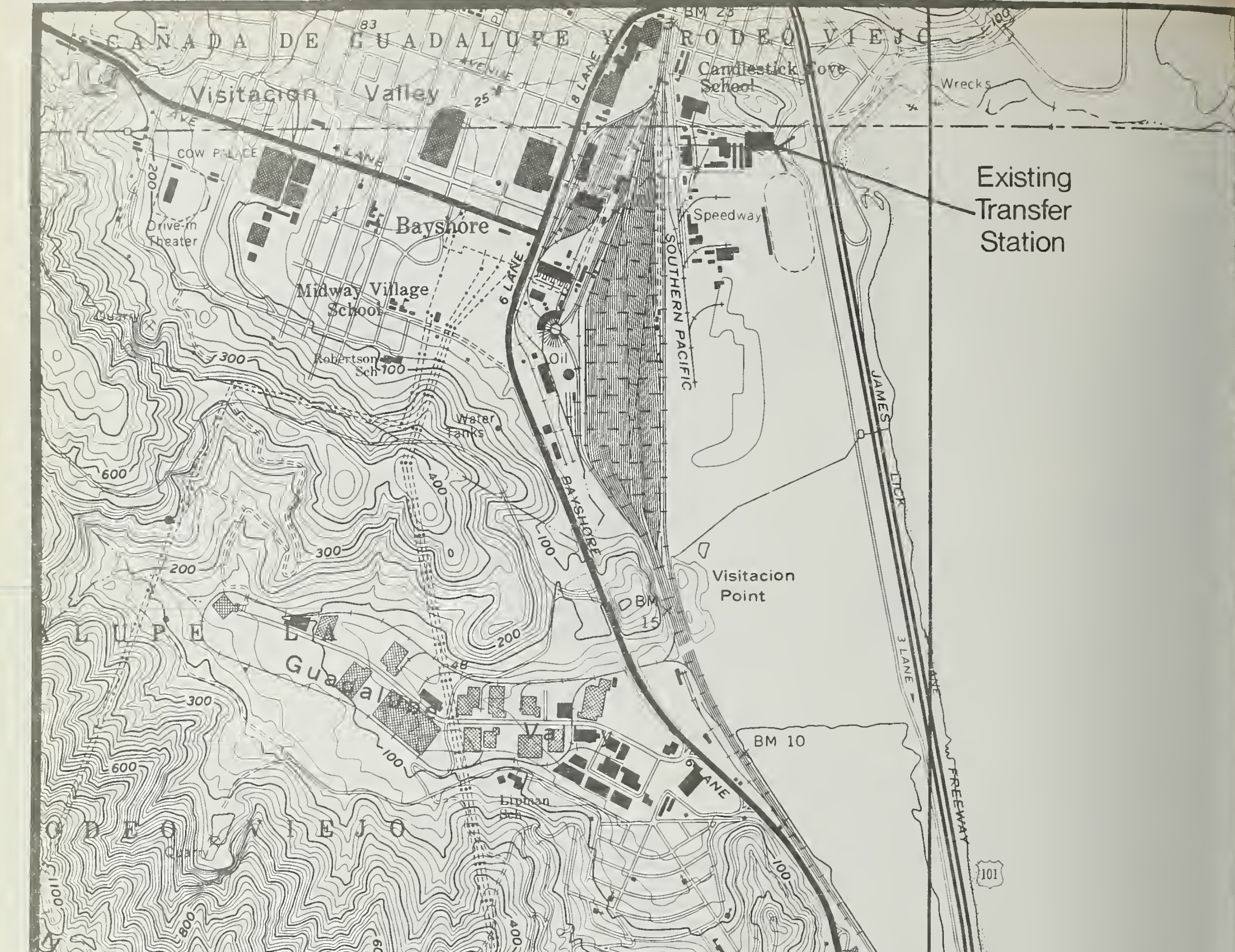
RICHMOND AND OAKLAND QUADRANGLE
U.S. Geological Survey
1:24,000

## Berkeley Site

## Figure 3

**Bay Delta Resource Recovery Demonstration Project**

**eip / ABAG**



SAN FRANCISCO SOUTH QUADRANGLE
U.S. Geological Survey
1: 24,000

**Sierra Point Site** **Figure 4**

**Bay Delta Resource Recovery Demonstration Project**

**eip/ABAG**

## C. OPERATIONAL DESCRIPTION

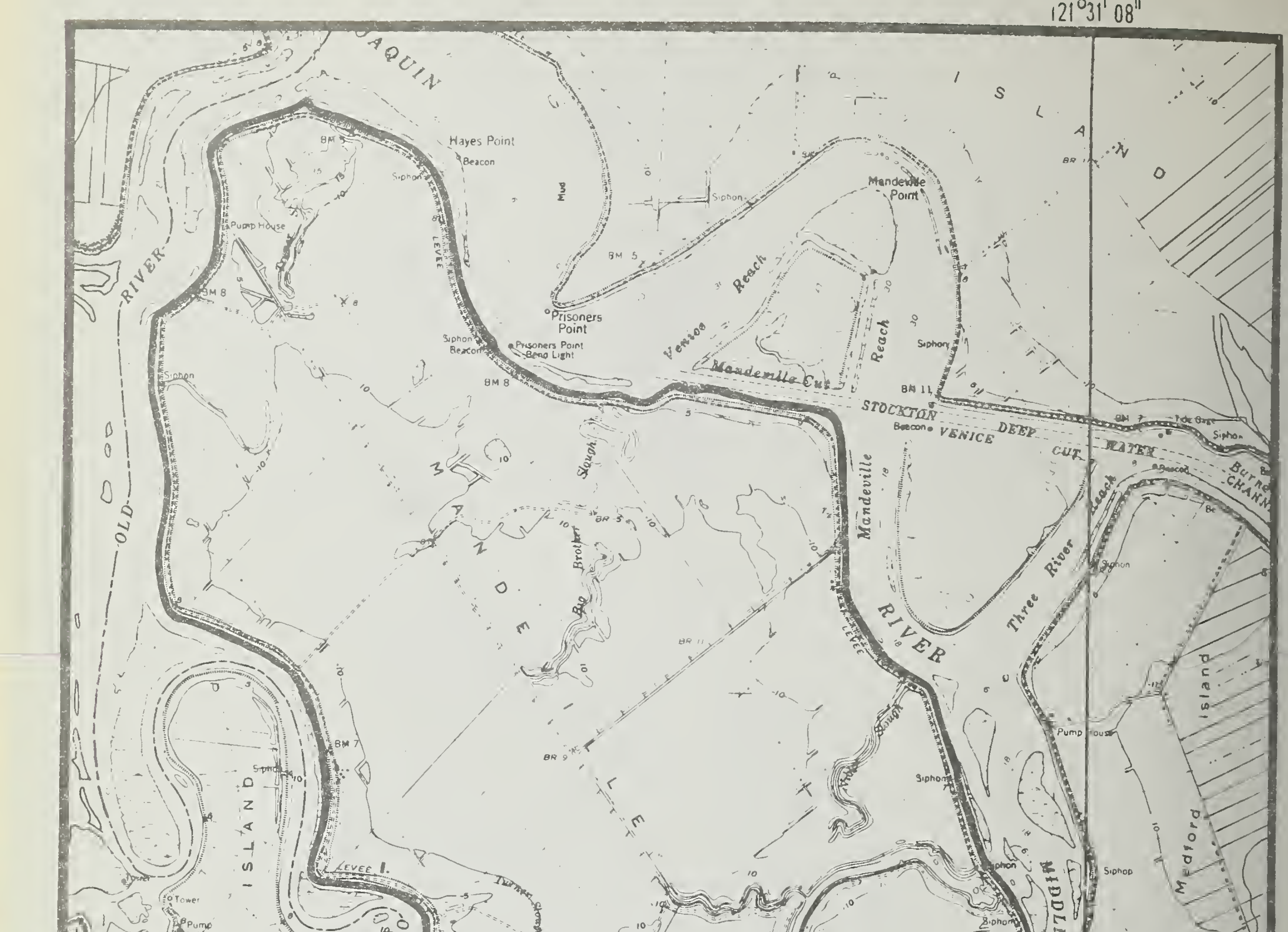
### 1. Processing and Resource Recovery

In Berkeley all refuse collected by municipal route trucks would be delivered to a transfer station for processing. This would total about 150 tons per day (46 truckloads, five days per week). An arrangement has been made with Oakland Scavenger Company to deliver an additional 50 tons per day should it be necessary for the Demonstration. The final design and layout of the transfer station will be developed as part of the Demonstration, but the following preliminary design offers a concept of the operation.[1]

The transfer station should have sufficient floor space for storing one day's refuse. The incoming material would feed into a shredding mill to reduce particle size to between two and six inches. The output of the mill is fed into an air classifier to separate the light material from the heavy fraction. The light material, estimated to be 85% of the total, consists mostly of paper and other organics and a small percentage of light plastics, such as polyethylene film. Approximately 125 tons per day of this material would be conveyed into self-unloading transfer trucks for delivery to the composting site at the Berkeley landfill. The heavy fraction, consisting of metals, glass, rubber, leather and heavy plastics, would pass through a magnetic separator to remove ferrous metals such as tin cans. About 5% of the input refuse (7.5 tons per day) is expected to be ferrous metal which can be sold for remelt to the steel industry. About 15 tons per day of the heavy fraction would remain, and it is unlikely that the small volume of metals and glass could be recovered economically. The heavy fraction that is not recovered for recycling would be disposed of at the Berkeley landfill.

---

[1] Newspaper recycling in Berkeley is accomplished by an ongoing program of householder separation and monthly collection and is not considered as part of the Demonstration project. Newspaper separation improves the carbon:nitrogen ratio of the remaining refuse for composting and is recommended to the maximum possible extent.

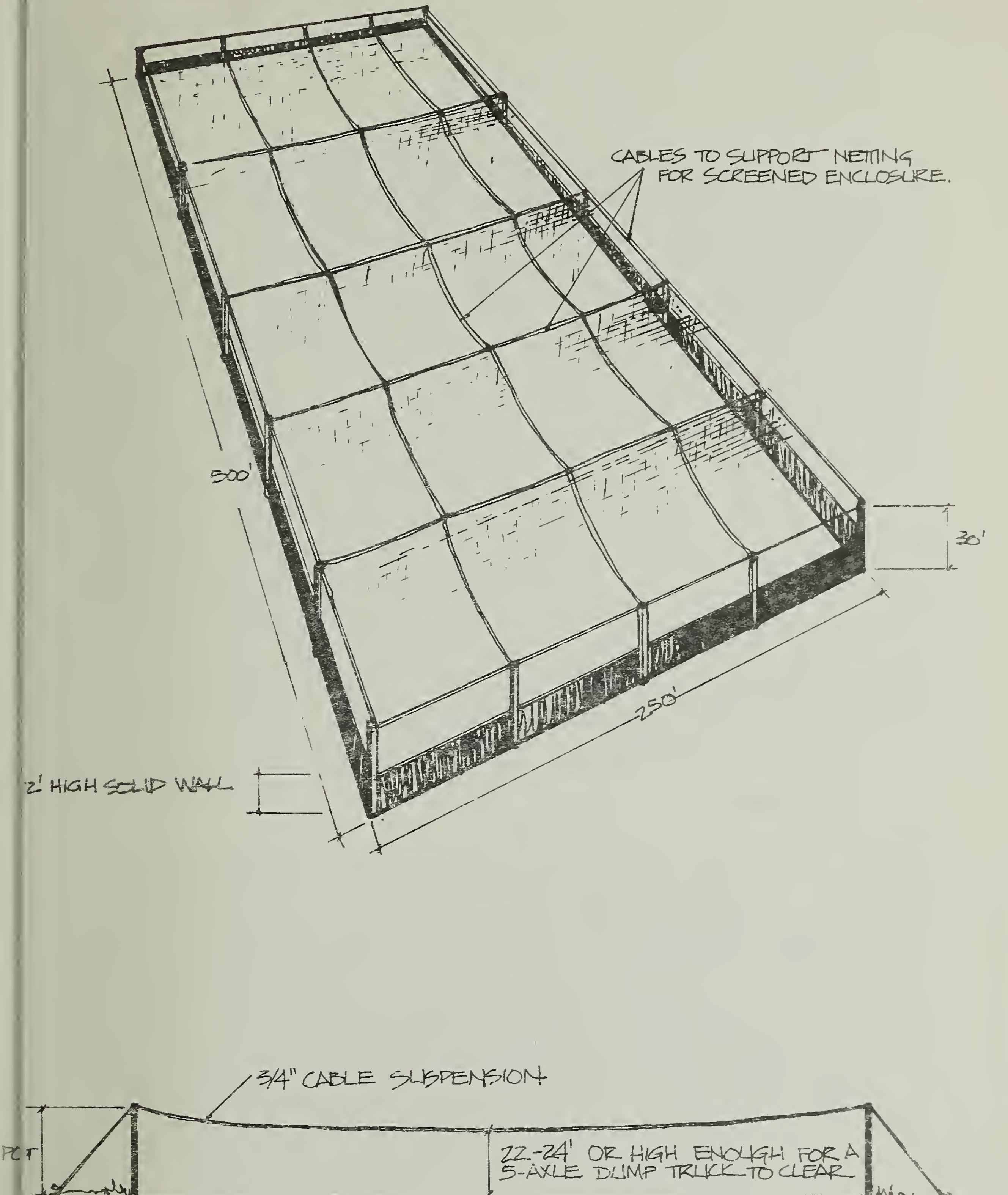


BOULDIN ISLAND QUADRANGLE
U.S. Geological Survey
1:24,000

**Mandeville Island Site** **Figure 5**

Bay Delta Resource Recovery Demonstration Project

eip / ABAG


CABLES TO SUPPORT NETTING FOR SCREENED ENCLOSURE.
500'
30'
250'
2' HIGH SOLID WALL
3/4" CABLE SUSPENSION
22-24' OR HIGH ENOUGH FOR A 5-AXLE DUMP TRUCK TO CLEAR
250'

**Composting Yard** **Figure 6**

**Bay Delta Resource Recovery Demonstration Project**

**eip / ABAG**

In San Francisco, 150 tons per day of shredded, air-classified organics would be obtained from the existing transfer station.[1] This station currently receives 2,000 tons per day of municipal refuse, about one-half of which is from residential collection. The residential refuse is delivered to one side of the building and passed through a hammer mill for rough shredding followed by magnetic separation of ferrous metals. An economic feasibility study of further resource recovery is currently being conducted under an EPA grant. If the study proves positive, then the operators of the station would install their own equipment for further shredding, air classification and recovery of aluminum and other non-ferrous metals and possibly glass. Of the light organic fraction from the air classifier, 150 tons per day would then be diverted for use in the Demonstration. If the study indicates the economic infeasibility of installing this resource recovery equipment, then the Demonstration would require the addition of a small shredding and air classification operation to the transfer station to produce the 150 tons per day of shredded organics. In either event, the material would be loaded into self-unloading vehicles for transport to the composting site at Sierra Point, about two miles away.

### 2. Composting

Composting is the high-speed decomposition of organic wastes to render a relatively stable, dark-brown humus product. This is accomplished by mechanical processing to maintain proper environmental factors of moisture, aeration, temperature, pH level and carbon:nitrogen ratio. It is the control of these variables that distinguishes composting from natural decomposition which occurs in an open dump, a sanitary landfill or a manure heap. Many different types of composting systems have been developed in the United States and Europe to achieve stabilization of organic wastes. The system chosen in the preliminary design for the Demonstration is aerobic windrow composting.

---

[1] As in Berkeley, newspapers are collected for recycling in San Francisco, and this operation is not included as part of the Demonstration project. Maximum source separation of newsprint is encouraged in San Francisco as well as in Berkeley.

At both the Berkeley and Sierra Point sites, up to 50 tons per day of vacuum-dried sewage sludge (20% solids) would be mixed with the organic refuse during the composting process. In Berkeley, sludge would be delivered by truck from the East Bay Municipal Utility District's secondary treatment plant in Oakland. At Sierra Point, sludge would be delivered from San Francisco's southeast sewage treatment plant, a primary treatment facility.

The composting operation would occur in a paved and enclosed composting yard. Shredded refuse and sludge would be mixed and formed into long piles called windrows. Machines would turn and moisten the windrows every few days to maintain aerobic conditions. Proper drainage should be provided to catch rainwater and leachate for recycling into the windrows so that no wastewater would be discharged from the operation. The yard can be enclosed with a cable-supported, wire mesh structure to contain any blowing shreds of paper (Figure 6). After several weeks of composting, the material would be screened to remove plastic film and oversize particles. The screened compost would then be trucked to the barge for transport to the Delta. Material not passing through the screen would require disposal at a landfill. Approximately 100 tons of screened compost per day would be produced at each site.

### 3. Transportation to Delta

Compost at each site would be loaded into a 600-ton barge docked in the adjacent waterway and shipped once a week to Mandeville Island. The preliminary design involves direct dumping by truck into the barge, as shown in Figure 7. Conveyor loading may also be considered in the final design. A 100-foot breakwater at the Berkeley loading site may be required to protect the loading facility.

Two barges would be needed for each site, one for loading and unloading at the composting site and the other for Mandeville Island. One tug would need to make one tow per week from each site. Figure 8 shows the transportation route from each composting site to the island.

The barge-unloading concept developed in the preliminary system design involves unloading at Mandeville Island by a 35-ton truck crane mounted on a wharf. Compost would be removed by a clamshell bucket and loaded into a dump truck. The truck would drive onto a trestle extending into the island to dump the compost onto the island surface (Figure 9). Unloading by covered conveyors can also be considered in the final design.

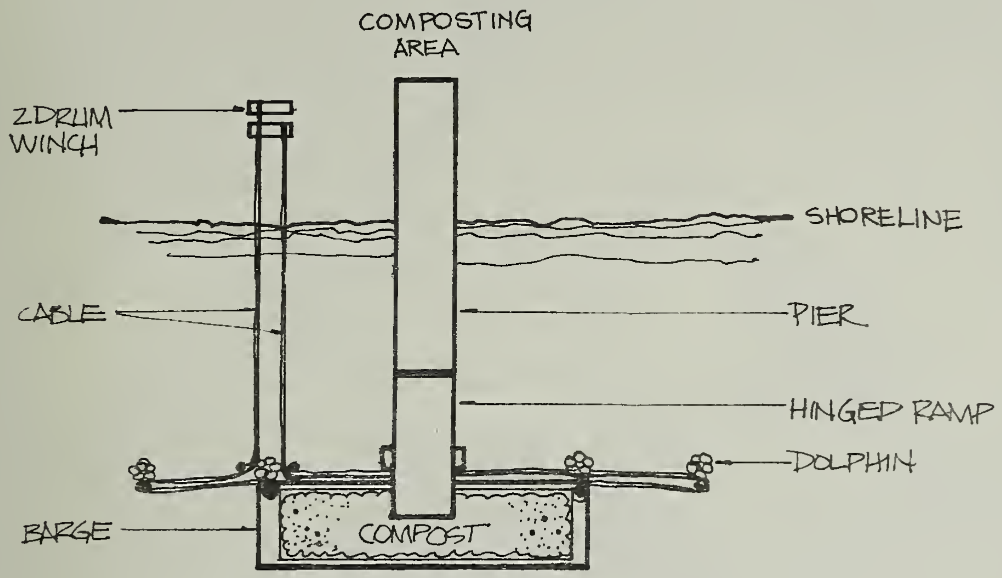
### 4. Compost Placement

Compost delivered to Mandeville Island would be used to construct a berm behind a test section of levee. The purpose of the berm is to strengthen the levee against failure from high water pressures in the outside water channel and to raise the elevation of the land for improved agricultural practices. Figure 10 shows a cross-section of the levee test site. This site was selected based on available topographic and soils information. Before the berm is built, a topographic survey and a thorough program of subsurface exploration at the site should be conducted.

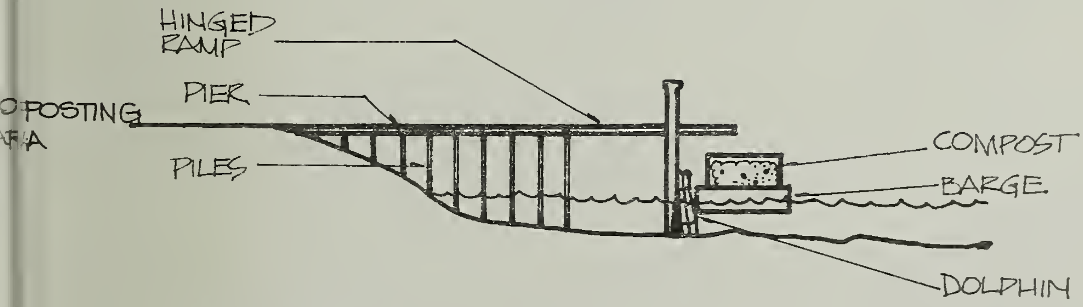
The berm would be built with a uniform slope of 25 horizontal to 1 vertical from the crest of the levee to the island floor. Since the levee is approximately 20 feet high, the berm would extend 500 feet inland from the levee crest. Compost would be moved from the base of the trestle to the placement area by a scraper vehicle and applied in wide, broad layers of approximately one foot thick. A crawler tractor would compact the compost to the required density. Before the compost is applied, a drainage system should be constructed to prevent water pressures from building up beneath the berm where seepage emerges from the levee and the adjacent ground.

Nonuniform settlement due to compression of the underlying peat would probably cause cracking of the levee, and repair of these cracks would be a necessary part of the construction operations. To prevent failures of the peat under the weight of the compost fill, the berm would have to be constructed slowly. All slopes, whether permanent or temporary, would have to be gradual. If the berm is built to the levee crest, approximately 1,800 feet of levee could be reinforced over a two-year period. Figure 11 shows the proposed completed compost berm.

An office trailer and graveled pad for vehicle parking would also be constructed at the site.



PLAN VIEW



SECTION VIEW

**Barge Loading Concept** **Figure 7**

**Bay Delta Resource Recovery Demonstration Project**

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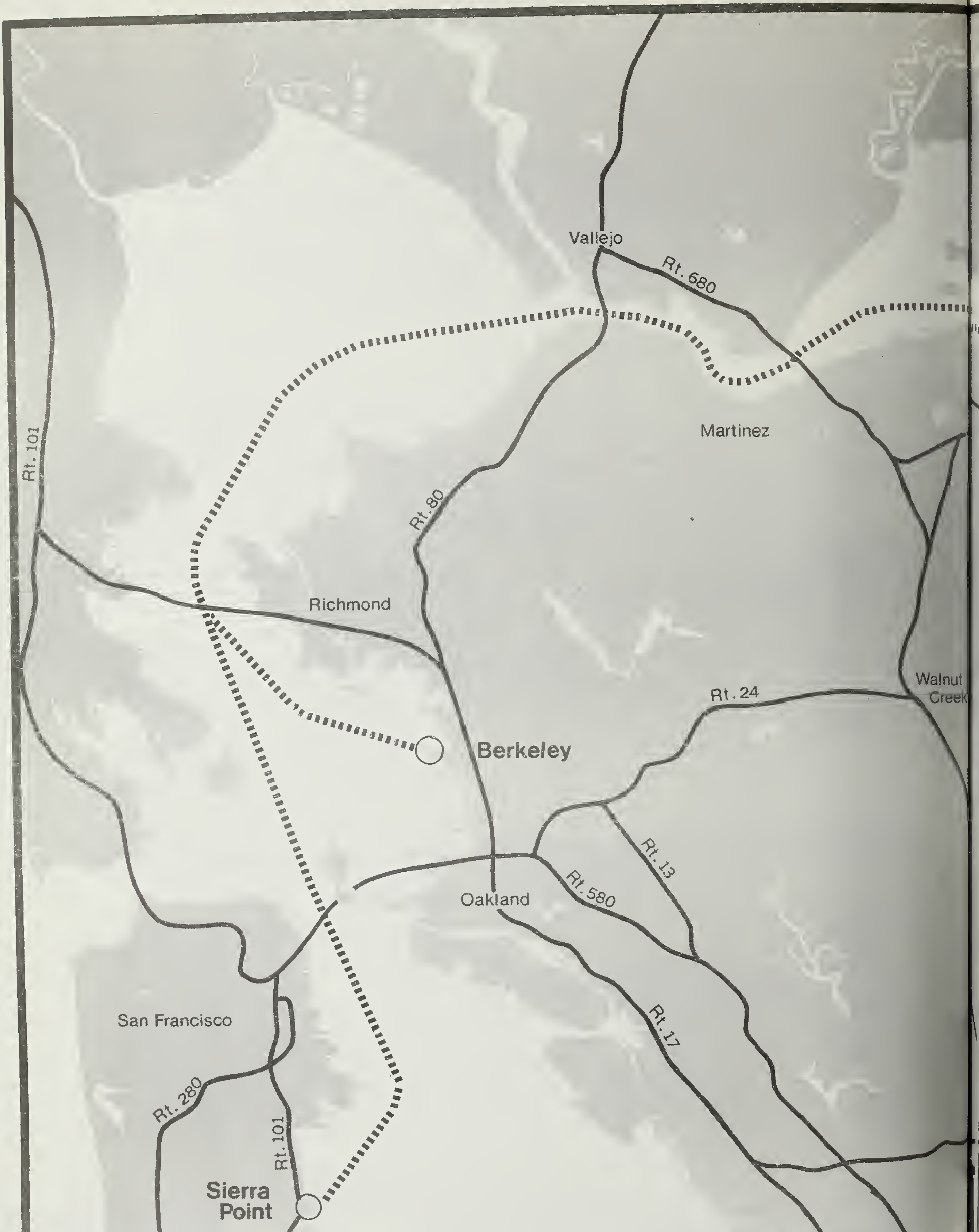
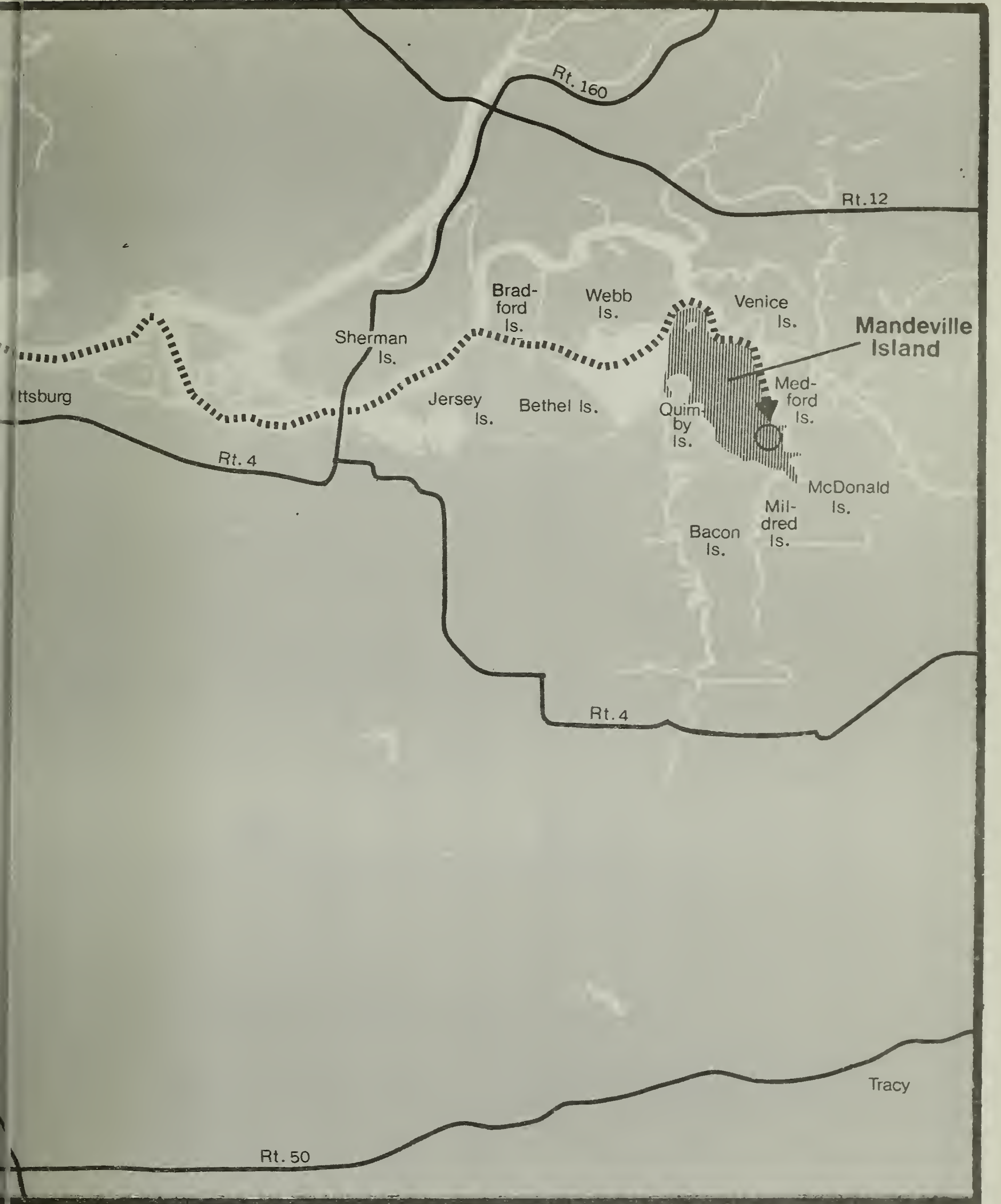
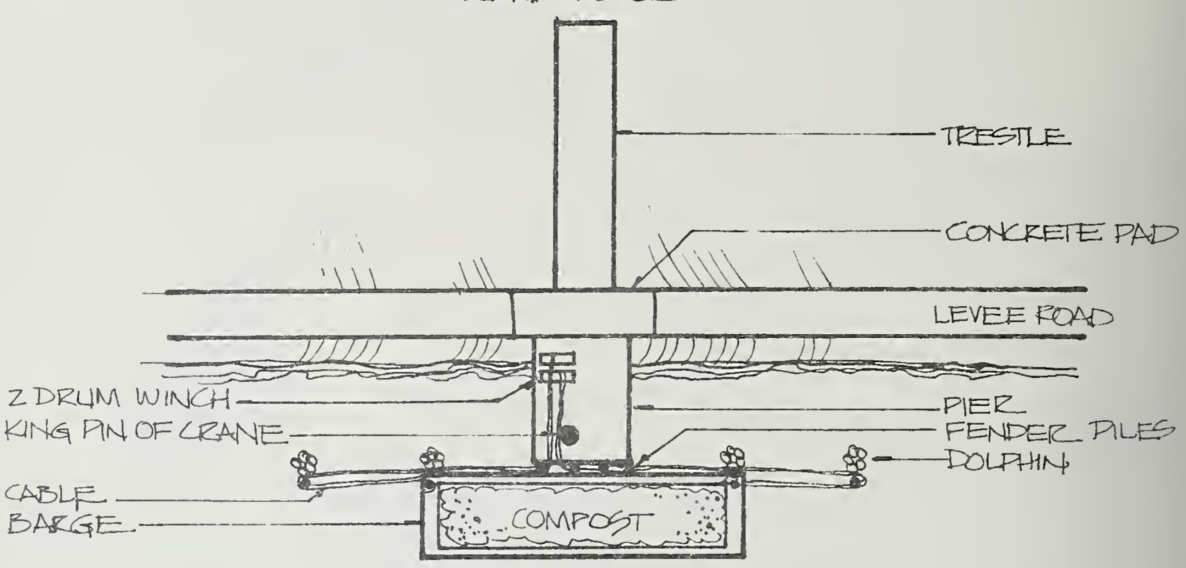

Vallejo
Rt. 680
Martinez
Rt. 101
Rt. 80
Richmond
Walnut Creek
Rt. 24
Berkeley
Rt. 13
Oakland
Rt. 580
Rt. 17
San Francisco
Rt. 280
Rt. 101
Sierra Point



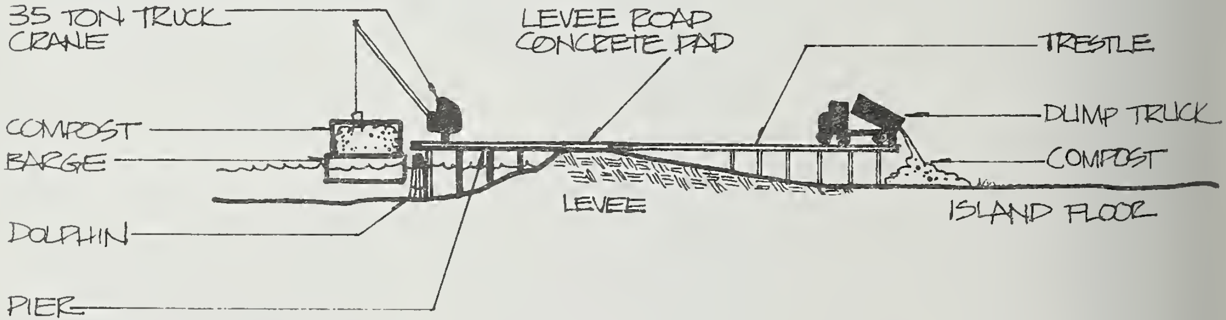
**Transport Barge Route** **Figure 8**

Bay Delta Resource Recovery Demonstration Project

eip/ABAG



PLAN VIEW



SECTION VIEW

**Unloading Barge Concept** **Figure 9**

**Bay Delta Resource Recovery Demonstration Project**

eip/ABAG

### 5. Monitoring

Monitoring of air quality, water quality, soil stability and biotic impacts would be conducted to determine the environmental effects of the composting operation and the compost berm. Knowledge would also be gained about the extent of composting required, materials handling techniques and levee reinforcement procedures that could be applied to a full-scale operation. After emplacement, as the surface of the compost decomposes and weathers with time into a soil-like mantle, the agricultural productivity of the material would also be monitored to determine the agricultural worth of compost as a parent material base for the development of a new organic soil.

#### . Water Quality

Water quality monitoring would involve three types of tests. First, tests would be conducted on the composting rocess itself. This would include sampling of both the olid material and leachate. Second, lysimeter tests ould be conducted to determine the water pollution potential of the compost berm behind the levee. A lysimeter tank would be filled with compost to simulate the berm and ould operate with either downward percolation of applied ater or with complete saturation of the bottom layers. hird, full-scale site tests would be conducted prior to nd during compost placement. A network of sampling oints would be established to permit the sampling of pplied water, drainage water and groundwater around the est levee site. These tests will furnish information on urrent water pollution levels to be used in comparison ith the net increment imposed by the compost berm. aboratory measurements of water quality would be grouped s follows:

(1) Toxicants (heavy metals, phenols, phthalates)

(2) Pesticides (chlorinated hydrocarbons, polychlorinated biphenyls--PCBs)

(3) Biostimulants (nitrogen, phosphorous)

(4) Oxygen-consuming potential (TOC)

(5) Pathogens (coliform)

(6) Mineral solids (electrical conductivity)

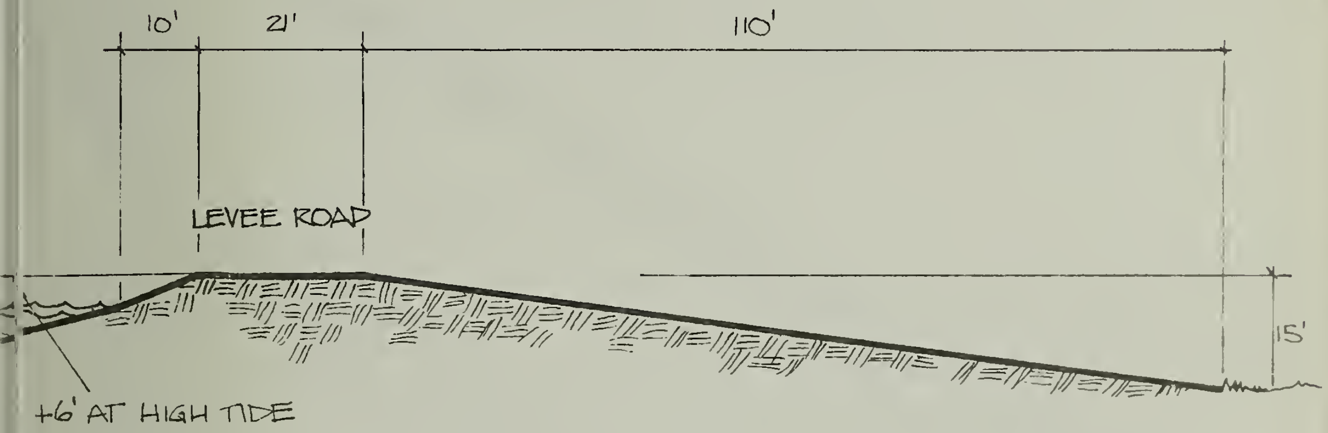
As the sludge and solid wastes from the two different sources may have considerably different properties, it may be useful to place the two composts at separate ends of the berm site to measure any differences in the quality of their leachate.

### b. Air Quality

The purpose of air quality monitoring during the Demonstration is to investigate what effect the use of compost as a levee reinforcement material will have on the air quality of Mandeville Island and the Delta, both during the unloading and placement procedures and after the fill is in place and begins to weather into soil. Visual observation is the most realistic procedure for evaluating air quality during compost unloading, placement and compaction. Observation would be made under both mild to moderate winds (10 to 15 miles per hour) and under strong winds (15 to 40 miles per hour). Attention would be directed toward the wind erodibility of small bits of plastic film. After reinforcement of a section of levee is completed and the final surface attained, the surface is expected to slowly weather into a soil-like mantle. The wind erodibility of this developing surface can be compared with that of nearby peat soils by the use of simple impinger samplers placed at ground level.

### c. Soil Stability

A number of field studies would be undertaken during the course of the Demonstration to monitor the affects of the berm. Settlements, horizontal movements and any spreading of the levee crest would be monitored carefully during the entire project. A thorough program of crack surveillance and repair would be continually conducted during and after construction.



NOTE:

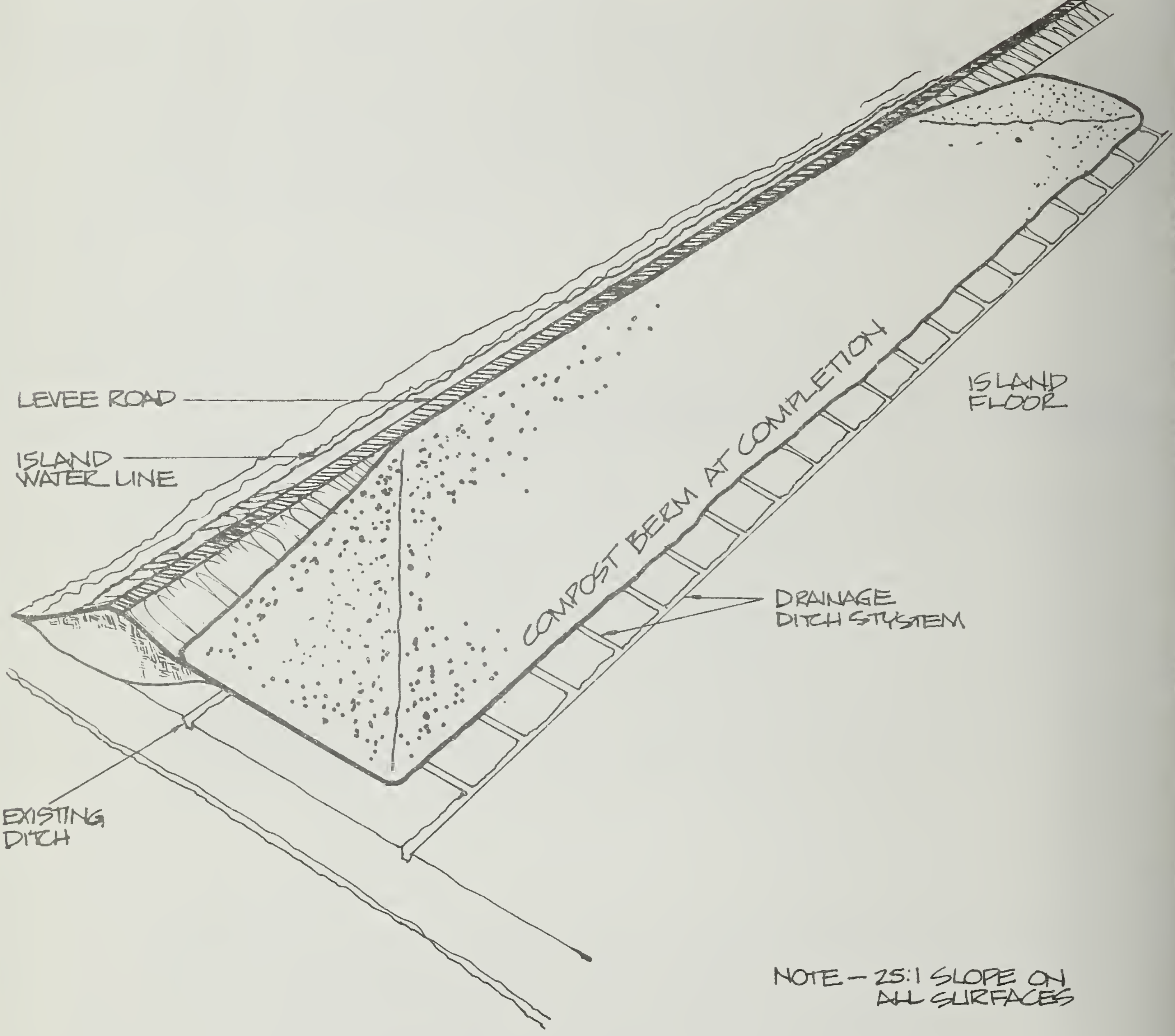
GENERAL ISLAND ELEVATION IS ABOUT 18' TO 20' BELOW THE TOP OF THE DIKE.

# Test Levee Cross Section

Figure 10

y Delta Resource Recovery Demonstration Project

/ ABAG



Compost Berm Concept Figure 11
Bay Delta Resource Recovery Demonstration Project
eip / ABAG

Piezometric (water pressure) levels in the drains and in the peat beneath the berm would be observed to insure that water pressures are maintained at low, safe levels by the drainage system. Densities and water content of the applied compost would be measured on a regular basis, and supervision would be provided to assure that the densities measured are representative of the entire fill. Permeability tests would be performed in the peat, the compost and the drain materials, using the falling head permeability procedure with standpipe piezometers. And finally, settlements within the berm and at the berm-peat interface would be monitored to check the accuracy of settlement predictions.

### d. Agricultural Productivity

Agricultural productivity experiments would be conducted during the Demonstration in the lysimeters used for measuring the quality of compost leachate. The purpose of these experiments would be to obtain preliminary information on how compost behaves as an agricultural soil. In the first year, barley may be the only feasible crop and its yield would be depressed due to the high organic content of the material. Particular attention would be paid to plant toxicity due to possible uptake of heavy metals from the compost. Leaf analysis should also be conducted for possible concentrations of elements toxic to animals but not to plants (e.g., molybdenum, arsenic, selenium). The need for mixing Delta peat, dredged sand or fertilizer with the compost material, as well as irrigation requirements, would be investigated to obtain preliminary information for later field research. Once a section of test berm is built behind the levee, experiments would be initiated to determine crop response under field conditions and to determine proper agricultural practices on an elevated section of Delta land.

### e. Biotic Effects

A comprehensive monitoring program would be conducted to provide data on the transportation of PCBs, phthalate acid esters, heavy metals and organochlorine residues from the compost material into the surrounding Delta environment. The monitoring must be initiated prior to any deposition of compost material and be conducted for a period long enough to compensate for the time lag involved in the leaching processes. The program should be structured as follows:

1. Establish a number of monitoring stations in the vicinity of the test site to monitor pollutant levels of soil and sediment samples. Samples taken prior to the project will indicate the undisturbed background levels, and it is recommended that these samples be taken along transects at varying distances from the test site, and at a frequency adequate to permit reliable statistical evaluation of the data. Emphasis must be given to soil and sediments rather than to water, since the latter is known to be unreliable for the investigation of pollutant contamination levels in wildlife.

2. Determine prestudy and poststudy pollutant concentrations in a carefully selected animal "indicator" species. Samples of a single or several indicator species would be taken from downstream and upstream of the study site at frequent intervals to provide reliable data on the trends and the distribution of pollutants. The indicator species selected should be a resident (and not a mobile animal), one that can be easily collected (i.e., abundant), and preferably a filter feeder. Potential candidates include a mollusk, the Asiatic clam *Corbicula fluminea*, the crayfish *Pacifastacus leniusculus*, the mysid shrimp *Neomysis awatschensis*, or the amphipod *Corophium*.[1] The mysid shrimp is probably the ideal species, since it is a major food item of striped bass, American shad, green sturgeon, channel catfish, black crappie and warmouth.[2] Analyses based on highly mobile or predatory fish

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[1] California Department of Fish and Game, *Ecological Studies of the Sacramento-San Joaquin Estuary*, 1972.

[2] *Ibid.*

are not reliable because it is impossible to isolate the source of contamination. It is imperative that the sampling be statistically defensible and provide useful information on the ecological impact of any contaminants introduced by the compost.

3. By sampling, determine the daily input of pollutants contained in the sewage sludge and refuse to provide essential background data.

## . Economic Characteristics

he estimated cost of conducting the Demonstration is 6.9 million as shown in the following table.

### PROJECT COST ESTIMATE

| | (A) Capital Costs | (B) Annual Operating Cost | (C)=(A)+2(B) Total Cost |
|---|---|---|---|
| rocessing/transfer station | $ 253,000 | $ 162,000 | $ 577,000 |
| omposting | 2,250,000 | 692,000 | 3,634,000 |
| arge transport | 500,000 | 545,000 | 1,590,000 |
| ompost placement | 110,000 | 200,000 | 510,000 |
| onitoring | 54,000 | 170,000 | 394,000 |
| roject supervision | | 50,000 | 100,000 |
| ther | 25,000 | 25,000 | 75,000 |
| | $3,192,000 | $1,844,000 | $6,880,000 |

he Demonstration would be sponsored and managed by an ntergovernmental agency of Bay Area jurisdictions. This gency would be responsible for fund-raising, cost-sharing rrangements among members, and other management aspects f the Demonstration.

## D. RELATIONSHIP OF THE DEMONSTRATION TO FEDERAL, STATE, REGIONAL AND LOCAL PLANS

### 1. Federal and State

The Demonstration is consistent with the Federal Resource Recovery Act of 1970 and State Senate Bill No. 5, both of which have three major common objectives:

1. The formation of intergovernmental entities to assume overall responsibility for solid waste programs and for equitable distribution of costs.
2. The formulation and adoption of comprehensive solid waste management plans on a regional or subregional level.
3. The requirement that solid waste management plans give maximum consideration to resource recovery.

One of the two major elements of the Demonstration is the establishment of a regional intergovernmental structure to carry out the physical demonstration and to formulate a method for equitable distribution of the costs. This element partially fulfills the objective for regional waste management plans by providing a component operation for such a plan and also by showing potential methods of initiating regional cooperation and agreements.

The physical plan, the Demonstration's other major element, is entirely dedicated to the principle of resource recovery. The Demonstration seeks to explore the feasibility of conversion of the organic component of solid waste to a composted material which could be used to restore or rebuild the earth's soil mantle. The primary emphasis would be on reinforcing the deteriorating levees of the Delta; however, the concept could be applied to land reclamation in other areas as well. Ferrous metal and possibly other resource recovery is also included in the Demonstration.

The Demonstration is also related to state plans outlined in "Delta Levees, What Is Their Future?"[1] This is a discussion of alternative courses of action for the Sacramento-San Joaquin Delta levees. Four alternatives are outlined:

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[1] California Department of Water Resources, Delta Levees, What Is Their Future?, September 1973.

Alternative A - No improvement
Alternative B - Extensive improvement
Alternative C - Moderate improvement
Alternative D - Polders (dikes surrounding a group of islands)

The Demonstration is in conformance with the concept of reinforcement of the inner portion of the levee, as stated in Alternatives B and C. However, it does not address either recreational development, widening of levee roads, or improvement of the outside of levees.

## 2. Local

### a. Berkeley

The Berkeley City Council has an existing policy to discontinue current landfill operations due to opposition to further bayfill.[1] For the past 18 months, it has been the responsibility of the City Council's Solid Waste Commission to find and investigate alternative methods of disposal. At their advice, the City Council on September 18, 1973, adopted a revised proposal to participate as a donor-city in the Demonstration. Their proposal includes the construction of a processing station and donation of land for the composting site.

The composting site on land reclaimed by the existing landfill operation in the northwest section of the Berkeley waterfront is planned as municipal recreational open space. Upon completion of the Demonstration, the composting site would be available for development as proposed and the transfer station and equipment could be operated and owned by the city as a component of their ultimate solid waste management system.

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[1] Conversation with Thomas Peak, Planning Director, City of Berkeley, November 6, 1973.

### b. San Francisco

Currently, San Francisco's municipal wastes are disposed of by the Sanitary Fill Company (S.F.C.) at the Mountain View landfill site.

This site has a life expectancy of two years under the current contract with the City of Mountain View. S.F.C. is studying future alternative operations or sites. Their participation in the Demonstration is a small-scale experiment to investigate the feasibility of this method of solid waste management for possible future utilization.

The Sierra Point compost site, under the jurisdiction of the City of South San Francisco, is zoned M-1, Heavy Industrial Development. The Demonstration's use of the site would be in conformance with this designation and would be a temporary use.

### c. Mandeville Island

Mandeville Island is under the jurisdiction of San Joaquin County and zoned EA-10, Exclusive Agricultural, 10-acre minimum parcel. It is classified as prime agricultural land by the adopted "Open Space Element" of the San Joaquin County General Plan.[1] The planning objective for this type of land is "To preserve in agriculture those lands suitable for various agricultural uses."[2] It further states, "A major objective of planning open space in an agriculturally prominent county is to preserve and enhance this important segment of the economy and to identify and protect the resources upon which it is based."[3] The Demonstration appears to be in direct compliance with these planning objectives.

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[1] Cities and County of San Joaquin Advisory Planning Association, Open Space Element, June 27, 1972, p. 21.

[2] Ibid.

[3] Ibid.

Mandeville Island is also in the Delta Advisory Planning Council (DAPC) study area. At this time, DAPC is preparing its Preliminary Comprehensive Plan for the Delta. No definitive, adopted plans are available at this time.

## E. JURISDICTIONAL BODIES AFFECTED

At all project locations, permit approval from various government agencies is required to help determine the feasibility of and requirements for the project. The Berkeley transfer station and composting operation fall under the primary jurisdiction of the Berkeley Services Department with input from the Planning, Public Works and Public Health departments. The Sierra Point composting site will require permit approval from the City of South San Francisco (the South San Francisco Planning Department requirements have not yet been confirmed). In addition, the U. S. Army Corps of Engineers will require permits for docking structures at both composting sites. The San Francisco Bay Regional Water Quality Control Board and the Bay Conservation and Development Commission will also require permit approval at both compost sites.

The San Joaquin County Planning Department has primary jurisdiction over the Mandeville Island test site with review by the Public Works and Public Health departments. The Corps of Engineers would require a permit for the docking structure; and the Central Valley Regional Water Control Board would review for approval the water pollution aspects of the Demonstration, possibly setting waste discharge requirements. Approval from the State Reclamation Board with an endorsement from the local board may be required.

Upon receiving applications, these agencies normally refer to other agencies for review and recommendation. Diplomatic review would come from various agencies including the following:

State Air Resource Control Board
State Lands Commission
State Department of Fish and Game
State Bureau of Mines and Geology
State Navigation and Ocean Development Department
State Conservation Department
Federal Bureau of Wildlife and Conservation
Association of Bay Area Governments
Delta Area Planning Council

# IV. ENVIRONMENTAL SETTING

## A. DELTA REGION

### 1. General Description

Mandeville Island, site of the project's compost placement operation, is one of the more than 50 islands and reclaimed tracts that comprise a major portion of the Sacramento-San Joaquin Delta. The Delta is a triangular-shaped area of approximately 740,000 acres (waterways amount to 50,000 acres) lying at the confluence of the Sacramento and San Joaquin rivers. These two rivers drain 37% of the land area of California and handle almost 47% of the natural runoff of the state. The Delta stretches from Sacramento on the north, Stockton on the east and Antioch on the west (see Figure 2).

Until large-scale reclamation began in the late 1800s, the Delta was a vast, shallow inland sea, with extensive tule growths covering deposits of peat. Reclamation was begun to provide agricultural land to feed California's increasing population during the Gold Rush of the 1850s. Reclamation involved construction of levees and draining of the enclosed lands. Currently there are over 1,100 miles of levees in the Delta, the result of over 100 years of reclamation.

The entire Delta--with the exception of the Montezuma Hills north of the Sacramento River and some areas along the south bank of the San Joaquin River east of Antioch--is approximately at mean sea level. Due to land subsidence, most of the islands and tracts of the Delta actually lie from 5 to 20 feet below mean average sea level and are maintained by levees. The Delta is a unique environment in California with its below-sea level islands and complex, interconnecting system of waterways, sloughs and deepwater channels. Because of its distinctive topography and visual quality, the Delta has been nicknamed "Netherlands of the West."

## 2. Geology and Soils

Geologically, most of the Delta has been formed from alluvial materials deposited by periodic flooding of major streams and is of the recent Quaternary period. The peat soils that exist over these deposits are the result of the partial decomposition of the surface of peat deposits built up over the past 10,000 years from extensive vegetative growth that existed between river channels prior to reclamation. Principal plants forming the peat are tule or bulrush (Scirpus species), common reed (Phragmites communis) and cattail (Typha species). Gradual increases in sea and river level and continued geologic subsidence have permitted the peaty layer to accumulate to a depth of as much as 50 feet in several places. Peat soils are highly organic and very productive agriculturally. They comprise about 150,000 acres of the Delta. The highly organic soils of the Delta are Correra, Staten, Venice and Egbert peat soils. Other types consist of associated soils in which advanced alteration and an admixture of mineral soils have played an important role.[1]

## 3. Land Use

The Delta is one of the most valuable resource areas of California. It has four major uses: agriculture, recreation, fishing and shipping.

Agricultural production in 1970 was estimated at over $140 million.[2] Principal Delta crops are asparagus, tomatoes, sugar beets, potatoes, sunflower, safflower, corn and small grains, with limited fruit and grape harvests.

The Delta supports some of California's greatest fishery resources. It is an important spawning ground and migration route for anadromous fish. It also provides habitat for resident game fishes such as catfish, black bass and crappie and is a vital food source of zooplankton, shrimp and benthos--i.e., clams, worms and insects. An ocean commercial salmon catch of over eight million pounds annually is supported by migration through the Delta to the Sacramento and San Joaquin rivers.[1]

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[1] Stanley W. Crosby, Soil Survey of the Sacramento-San Joaquin Delta Area, California, Series 1935, No. 21.

[2] California Department of Water Resources, Preliminary Report to the California Legislature on a Multiple-Purpose Levee System for the Sacramento-San Joaquin Delta, February 1970.

Recreational use, with a resident population of over four million within a one-hour drive of the Delta, is estimated to be 5.7 million recreational user days in 1973. The primary recreation activity is fishing, followed by pleasure boating.[2]

The Delta channels, particularly the Sacramento and San Joaquin rivers, are used for commercial shipping from the ports of Sacramento and Stockton. About 7,500,000 tons of cargo annually move through the Delta waterways.[3] The Sacramento-San Joaquin Delta also serves as a source of domestic and industrial water for Contra Costa and Solano counties.

### 4. Air Quality and Climatology

The Delta area--with hot, rainless summers and cool, moist winters--has a Mediterranean type of climate. The cooling ocean breezes blowing inland through the Carquinez Straits usually reduce summer temperatures in the Delta to below those of other parts of the Central Valley. Because of this, most of the Delta may be considered the cool Mediterranean subtype (Csb) of Köppen's classification.[4] The mean annual temperature is about 60°F (18°C).

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[1] California Resources Agency, Water Development and the Delta Environment, Report No. 7, December 1967.

[2] Delta Master Recreation Plan Task Force, Delta Master Recreation Plan, February 1973.

[3] California Department of Water Resources, Preliminary Report.

[4] Vladimir Köppen, Die Klimate Der Erde (Berlin, 1923).

The range is from 45°F to 50°F (4°-5°C) for the winter months and 70°F-75°F (21°C-22°C) for the summer months. During winter months, the presence of large, open bodies of water combined with low elevation present excellent conditions for the formation of fog. The "tule" fogs of the Delta may last for weeks and are known for their density.[1] The mean annual rainfall in the Delta depends on location. A maximum of approximately 14" of precipitation occurs in the central and eastern sections, while a minimum of 10" occurs in the southern part. Mt. Diablo, which blocks the prevalent winds from the southwest, causes this lower precipitation zone. Over 50% of the area's precipitation occurs during the winter with spring and fall months accounting for the remainder. Summer months are usually rainless.[2]

Air quality in the Delta is variable. In the winter months, air quality is generally good; however, significant concentrations of photochemical oxidant and suspended particulate matter are often recorded at the nearby air monitoring station at Pittsburg during the summer.

Photochemical oxidant is produced by the reaction of pollutants, mainly hydrocarbons and nitrogen dioxide with sunlight. Although these precursor pollutants are not produced in significant amounts in the Delta area, they are produced in large quantities in the highly urbanized and industrialized areas west of the Delta. Winds blowing through Carquinez Straits transport photochemical smog into the Delta area a significant number of days during the summer months. Concentrations of other pollutants such as carbon monoxide, sulfur dioxide and nitrogen dioxide seldom reach high values. Misuse of agricultural chemicals and pesticides occasionally cause air pollution problems of short duration.

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[1] Contra Costa County Planning Department, Land Use and Transportation Study, Inventory for the Conservation Element, August 1971, p. 78.

[2] U.S. Department of Agriculture, "Soil Map, Sacramento-San Joaquin Delta Area," 1935, p. 78.

Dust storms are a problem in the summer months, causing high values of suspended particulates. These dust storms generally occur in the afternoon when winds exceed 15 mph. Westerly winds prevail during the summer and spring, ranging from northwest to southwest, depending on location in the Delta. Fall and winter winds are more variable, with occasional strong northerly winds and southerly winds associated with winter storms.

### 5. Vegetation

The existing vegetation in the Delta is the result of almost total alteration of the extensive tule marshes that existed prior to reclamation. Small nonagricultural islands and the margins of the larger agricultural islands, where not denuded as part of levee maintenance procedures, still support growth of common tule and bull tule. Common tule is from three to nine feet tall and grows in both fresh and salt water. Bull tule is a shorter-growing tule, averaging one to three feet in height, and grows only in salt marshes or on moist alkaline soils.[1]

As a result of past reclamation activities, the aquatic vegetation of most islands has been replaced by salt grass, red top and other European grass introductions, in addition to a wide array of cultivated crops. Limited areas of natural vegetation scattered throughout the Delta consist primarily of streamside vegetation including willows, western sycamore and fremont cottonwood.

### 6. Wildlife

The Delta provides an invaluable habitat for migratory waterfowl on the Pacific Flyway and for a multitude of resident wildlife species; a total of some 16 species of ducks, 5 species of geese and 1 species of swan use the Delta area.

It has been estimated that an average of 10 million ducks and one million geese regularly winter in California, the majority using the Delta, Central Valley and San

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[1] Conversation with Mr. Jack Downs, special agent in charge of U.S. Bureau of Sport Fisheries and Wildlife, Sacramento office.

Francisco Bay areas.[1] Delta waterways and adjacent farmlands are classified as prime waterfowl habitat, and San Joaquin County consistently rates in the first ten in hunter bags of ducks and geese.[2]

Agricultural lands, in combination with surrounding riparian vegetation used as nesting areas, provide important food sources for pheasants, owls, quail, doves and songbirds, as well as for jackrabbits, cottontails and bush rabbits. Other common wildlife species found near waterways include the grey squirrel, badger, beaver, muskrat, mink, raccoon, river otter, grey fox and Columbian black-tailed deer.[3] Irrigation ditches extend the normal habitat for water-related and other species which would not normally live in a dry area.

## 7. Socioeconomic Setting

The Delta's economy is based primarily on agriculture. A secondary revenue source is from recreational use of the area. There are no large cities within the Delta, and most commercial and cultural activities are provided by Sacramento, Stockton, Pittsburg and Antioch. The only population centers within the Delta are Isleton (population 1,000) and Rio Vista (population 2,900).

Mandeville Island is part of U.S. Census Bureau Tract No. 39 which also includes Quimby, Bacon, Woodward, Victoria, McDonald, Medford, Coney, Fabian, Roberts, Mildred, and Rough and Ready islands, plus Lower Jones, Upper Jones and Hennings tracts.

1970 U.S. Census figures for Tract No. 39 indicate that it has a resident population of 3,246 people of which 47% are of Spanish surname, 66% of the male employed population are farm workers, the average education is limited to elementary school, and 51% are foreign born.

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[1] Suisun Soil Conservation District Final Report, Phase 1, Solano County, p. C-14.

[2] California Department of Fish and Game, California Fish and Wildlife Plan, Volume III, Supporting Data, Part A, Inventory (Wildlife and Island Fish), 1965.

[3] Conversation with Mr. Jack Downs, special agent in charge of U.S. Bureau of Sport Fisheries and Wildlife, Sacramento office.

Family size averages four persons and the average income is $8,234. Most of the residents live near enough to their work to walk rather than having to use private or public transportation.

### 8. Transportation

Major transportation routes to the Delta are Interstate 580 from the mid-Bay Area (Oakland); Interstate 5 from the north and south and State Highway 4 running east-west through the Delta from Stockton to north Contra Costa County. State Highway 160 parallels the Sacramento River from Antioch to Sacramento, while Highway 12 traverses the Delta from Rio Vista to Lodi and U.S. 99.

### 9. Special Problems

Special problems exist in the Delta which are the result of the unique origin, location and use of the area. These include levee instability, land subsidence and water quality problems, including saline intrusion.

#### a. Levee Instability

The majority of the 1,100 miles of levees in the Delta are placed on highly unstable peat soil foundations which are prone to failure under stress from high tides, erosive flood flows, wind- and boat-induced waves and seepage forces. In 1966, the Army Corps of Engineers identified over 200 miles of levees that were in some state of deterioration. Recreational use also aggravates the problem of levee instability by wave erosion and increasing traffic on levee roads.[1]

#### b. Land Subsidence

When exposed to air, peat soils of the Delta naturally oxidize into carbon dioxide and water and small amounts of soluble and insoluble inorganic materials. Agricultural operations speed up this natural oxidation process while reducing or eliminating the aquatic plants which are the source of peat. This phenomenon--coupled with wind erosion, compaction due to agricultural equipment use,and burning--has caused an average annual subsidence of island surfaces of two to three inches, or between 15 and 20 feet of subsidence since reclamation began.

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[1] California Department of Water Resources, Preliminary Report, p. ix.

### c. Water Quality

The water quality of the Delta is degraded by a number of factors. A salinity gradient (ranging from fresh to salt water) exists in the Delta which fluctuates seasonally and is dependent upon fresh water flow through the Delta. Saline intrusion occurs when the normal hydraulic barrier between saline Suisun Bay waters and the Delta is breached. The tidal action near Pittsburg and Antioch then forces saline waters into the Delta. These saline waters considerably degrade the water quality in the area. A recent example of a serious saline intrusion was the Andrus-Brannan Island flood of 1972.

The other specific water quality problem in the Delta results from agricultural drainage waters that are pumped into the waterways from the islands. These waters contain variable amounts of agricultural chemicals applied to the land in the form of fertilizers, soil amendments and pesticides, and mineral salts that are leached out of the soil.

These two water quality degradation problems can cause serious algae blooms, may be harmful to fish and can, if too concentrated, make Delta water unsuitable for agricultural and domestic drinking water uses.

## B. MANDEVILLE ISLAND

### 1. General Description

Mandeville Island, which consists of 5,700 acres of primarily agricultural land, was reclaimed in 1918 and has been in agricultural production since 1920. The island has been owned and farmed by the Zuckermann family since 1920, Alfred Zuckermann being the current owner. In the past, the island's production was primarily asparagus and potato crops. Currently, small grain crops dominate production.

Mandeville Island has approximately 14 miles of levees which are maintained by Reclamation District 2027 at an annual cost of $40,000-$50,000.

## 2. Geology and Soils

The island's geology and soils are typical of the Delta. The Delta has experienced considerable geologic subsidence or downwarping since the latter part of the Cretaceous period, 70 million years ago. Before the more recent uplift and emergence of the coast ranges, the Delta and most of the Central Valley area were submerged beneath the sea. The development of the coast ranges and subsequent Central Valley sedimentation forced out the sea by depositing a thick layer of alluvium.

On Mandeville Island the Quaternary age alluvial deposits are overlain by three soil types. The most extensive of these is Venice peaty muck,[1] an acidic, organic muck. It has a partly decomposed surface layer. Fragments of tules (bulrushes) are visible throughout. Beneath the surface soil, the subsoil is a true peat which rests upon the fine-grained alluvial substrata. Staten peaty muck covers roughly 10% of the island surface. This peat soil is much like the Venice peaty muck, although it is distinguished by being more completely decomposed. It is also characterized by the presence of more soluble salts and a more neutral pH, or acidity. The Ryde soil covers somewhat less area than the Staten peaty muck. This is a partly organic and partly mineral soil which has formed through deposition of alternating layers of silt and peat. The Ryde soil was formed because of its proximity to the river. The slough channels in which it is found received more river silt than the interior soils of the island during natural (prereclamation) flooding. All three of these soils are highly productive and have a high water-holding capacity. The soil at the compost placement site is Venice peaty muck.

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[1] U.S. Department of Agriculture, Soil Survey of the Sacramento-San Joaquin Delta Area, California, 1941, p. 18.

## 3. Seismicity

Although the Delta area has been seismically active in the geologic past, it has been relatively quiet in the period of record. A compilation of earthquakes of magnitude 4.0 in California occurring between 1934 and 1961 published by the State Department of Water Resources shows the nearest earthquake epicenter to be 25 miles from the test site. Two known faults lie closer than that at a distance of 20 miles; however, these have remained relatively inactive. Epicenters located within 30 miles were as follows:[1]

| | | |
|---|---|---|
| Peters | September 1940 | 4.0 |
| Livermore | April 1943 | 4.0 |
| Livermore | April 1943 | 4.1 |
| East of Livermore | May 1946 | 4.6 |
| Concord | October 1955 | 5.4 |
| Concord | May 1958 | 4.1 |

It is important to note that in the 1906 earthquake centered at Olema (magnitude 8.3), none of the levees existing at that time failed, possibly due to the physical properties of the peat underlying the whole area. Apparently, the ability of peat to transmit or amplify destructive seismic shocks is very small.[2]

## 4. Visual Quality and Noise

Visual experiences on Mandeville Island are similar to those of other Delta islands, dominated by expanses of open cultivated fields and narrow sloughs and waterways. Limited natural vegetation, primarily patches of tule, exist along aquatic margins.

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[1] California Department of Water Resources, Crustal Strain and Fault Movement Investigation, Faults and Earthquake Centers in California, Bulletin No. 116-2. January 1964, p. 61.

[2] H. Bolton Seed, University of California, Berkeley, personal communication, October 1973.

The low relief of the area, with a few manmade structures and trees, allows the open view of the sky to become a major visual element. During clear weather, views of the Coast Range and Mt. Diablo to the west and the Sierras to the east are impressive.

The site has low ambient noise levels, with the majority of noise generated by infrequent use of agricultural equipment and powerboat use in adjacent waterways.

## 5. Vegetation

The natural freshwater marsh vegetation of Mandeville Island was replaced many years ago with the introduction of agricultural land uses to the area. In the undisturbed condition, these freshwater marshes consisted of such species as the bulrushes or tules (*Scirpus robustus*, *S. Olneyi*, *S. cernuus* var. *californicus*, and *S. acutus*), the common cattail, the narrow-leafed cattail, the spikerush (*Heleocharis* species) and several sedges.[1]

The agricultural conversion of Mandeville Island is almost totally complete--almost none of the original vegetation remains. Cultivated crops are planted up to the crest of the levee that serves as a roadway as well as a barrier to flooding. Nonagricultural vegetation is restricted to isolated and highly modified stands that occupy some drainage ditches and sections of the island's shoreline. Small stands of common tule occur along the edges of the San Joaquin waterway, while patches of introduced annual grasses and weeds grow in some areas of the island. No marshland or riparian growth occurs at the proposed levee reinforcement site. Crops normally raised at the site include oats, milo and corn.

## 6. Wildlife

With the elimination and modification of marshland habitat, there have been accompanying changes in the wildlife of the area. Totally aquatic species have been eliminated from the island ecosystem and have largely been replaced by visiting terrestrial or dryland species that are capable of coexisting with the agricultural activities. Pintail, shoveler, American widgeon, green-winged teal and ring-necked duck are the most important migratory species. Marshes and waterways provide habitat for several species of resident ducks including the mallard, cinnamon teal, wood duck, redhead, canvasback and ruddy duck. The Canada, white-fronted and snowgoose are the most common geese of the Delta area. Although geese use marshy areas for refuge, they regularly visit the cultivated fields primarily in search of grains and grasses for food during their winter residence.

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[1] H. L. Mason, *A Flora of the Marshes of California* (University of California Press, Berkeley, 1957), p. 878.

Agricultural activities generally limit the value of Mandeville Island to most other wildlife. Only those species capable of exploiting the artificial food supplies and limited cover are of any significance. These include highly mobile ground-feeding passerine birds and the more adaptable small mammals, represented respectively by blackbirds, cowbirds, herons, crows, goldfinches, sparrows and the Audubon cottontail, pocket gopher, raccoon and skunks. The introduced pheasant is a major gamebird species on the island, although hunting by the public is prohibited.

The waterways provide highly productive fish habitat and are major routes in the migration of anadromous fish such as the king salmon, steelhead trout, striped bass, white sturgeon and American shad.[1] All these species use the waterways adjacent to Mandeville Island, although use by shad and sturgeon of the immediate vicinity is very limited. Although spawning activities are extremely limited, the middle and lower reaches of the San Joaquin River and adjacent sloughs are important nursery grounds, particularly for the striped bass. Juvenile striped bass use the shoal areas during a significant part of their maturation when they consume large quantities of the Mysid shrimp (Neomysis awatschensis). Local forage fishes are important food items in diet of older striped bass.

Sacramento smelt use local portions of the San Joaquin River principally during the winter and spring seasons, while green and white sturgeon, starry flounder, brown bullhead, black bullhead, channel catfish, white catfish, black crappie, bluegill, warmouth, carp, Sacramento squawfish, golden shiner and several others are permanent residents.[1]

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[1] California Department of Fish and Game, Ecological Studies of the Sacramento-San Joaquin Delta, Part II, Fishes of the Delta, Fish Bulletin 136, 1966, p. 168.

## 7. Climate and Air Quality

The climate and air quality of Mandeville Island is similar to the rest of the Delta. Climatological data for Mandeville Island is shown in Table 1. Mandeville Island has a modified marine climate, with generally light and seasonal rainfall. Temperatures are mild but have a greater range than areas closer to the ocean. Summer winds are almost exclusively from the West. In winter, winds are more variable and generally lighter.

Air quality data for Stockton and Pittsburg are given in Tables 2 and 3. Pittsburg is located at the west end of the Delta and Stockton is located at the east end. Both stations record frequent occurrences of oxidant smog which exceed the federal standard, while carbon monoxide and nitrogen dioxide concentrations seldom exceed the standards.

Suspended particulate matter is also an air quality problem in the Mandeville Island area. Table 4 shows that high concentrations of particulate matter are much more frequent at Stockton than other areas in the San Francisco Bay region. This is due partly to Stockton's position downwind of the Delta where peat dust is eroded away by the wind. This erosion is greatest during the summer when the soil is dry and winds are high. Generally, winds greater than 15 miles per hour are required to lift peat soil particles into the air. Winds of this strength occur approximately 9% of the time at Stockton, the nearest U.S. Weather Bureau station.

## 8. Land Use

Most of the island's interior is used for agricultural crops, as mentioned. Production figures for 1972 were:

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[1] California Department of Fish and Game, Ecological Studies, p. 168.

# TABLE 1

## CLIMATOLOGICAL DATA FOR MANDEVILLE ISLAND

### Rainfall[1] and Temperature[2]

| | Rainfall (Inches) | Mean Max. Temp. (°F) | Mean Min. Temp. (°F) | Mean Temp. (°F) |
|---|---|---|---|---|
| January | 2.75" | 53.8° | 37.1° | 44.7° |
| February | 2.94 | 59.4 | 38.7 | 48.8 |
| March | 1.31 | 65.3 | 39.7 | 52.8 |
| April | 1.25 | 72.5 | 43.9 | 58.1 |
| May | 0.60 | 78.8 | 47.8 | 63.4 |
| June | 0.04 | 86.0 | 51.9 | 68.8 |
| July | 0.00 | 92.0 | 54.1 | 72.7 |
| August | 0.00 | 89.9 | 52.3 | 70.9 |
| September | 0.39 | 87.1 | 50.4 | 68.6 |
| October | 0.44 | 78.2 | 45.0 | 61.2 |
| November | 0.77 | 65.0 | 38.6 | 51.6 |
| December | 1.84 | 55.4 | 36.7 | 45.8 |

### Wind Direction[3] (% of time)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| N | 4.9% | E | 3.0% | S | 2.2% | W | 19.0% |
| NNE | 1.4 | ESE | 3.1 | SSW | 1.0 | WNW | 13.2 |
| NE | 2.0 | SE | 6.6 | SW | 3.4 | NW | 15.5 |
| ENE | 0.9 | SSE | 3.0 | WSW | 6.5 | NNW | 5.0 |

### Windspeed (% of time)

| 0-3 MPH | 4-10 MPH | 11-20 MPH | 21-30 MPH | Over 30 |
|---|---|---|---|---|
| 20% | 43% | 33% | 3% | 1% |

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[1] U.S. Department of Commerce, Climatography of the United States, No. 86.4, 1972.

[2] Pacific Gas & Electric Company, Mean Hourly Temperatures, 1967.

[3] California Department of Water Resources, Office Report on Wind in California, August 1960.

## TABLE 2

## OCCURRENCES OF POLLUTANT CONCENTRATIONS EXCEEDING AIR QUALITY STANDARDS AT STOCKTON, 1972[1]

| | Pollutant | | | | | |
|---|---|---|---|---|---|---|
| | Oxidant[2] | | Carbon Monoxide[3] | | Nitrogen Dioxide[4] | |
| | Hours | Days | Hours | Days | Hours | Days |
| January | 0 | 0 | 0 | 0 | 0 | 0 |
| February | 0 | 0 | 0 | 0 | 0 | 0 |
| March | 5 | 2 | 9 | 2 | 0 | 0 |
| April | 0 | 0 | 0 | 0 | 0 | 0 |
| May | 1 | 1 | 0 | 0 | 0 | 0 |
| June | 1 | 1 | 0 | 0 | 0 | 0 |
| July | 0 | 0 | 0 | 0 | 0 | 0 |
| August | 22 | 7 | 0 | 0 | 0 | 0 |
| September | 19 | 8 | 0 | 0 | 0 | 0 |
| October | 1 | 1 | 16 | 2 | 0 | 0 |
| November | 0 | 0 | 0 | 0 | 0 | 0 |
| December | 0 | 0 | 0 | 0 | 0 | 0 |

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[1] California Air Resources Board, California Air Quality Data, February 1973.

[2] Federal standard for oxidant is 0.08 PPM (one-hour average).

[3] Federal standard for carbon monoxide is 9 PPM (eight-hour average).

[4] California standard for nitrogen dioxide is 0.25 PPM (one-hour average).

## TABLE 3

## OCCURRENCES OF POLLUTANT CONCENTRATIONS EXCEEDING AIR QUALITY STANDARDS AT PITTSBURG, 1972[1]

| | Pollutant | | | | | |
|---|---|---|---|---|---|---|
| | Oxidant[2] | | Carbon Monoxide[3] | | Nitrogen Dioxide[4] | |
| | Hours | Days | Hours | Days | Hours | Days |
| January | 0 | 0 | 0 | 0 | 0 | 0 |
| February | 0 | 0 | 0 | 0 | 0 | 0 |
| March | 5 | 2 | 0 | 0 | 0 | 0 |
| April | 6 | 2 | 0 | 0 | 0 | 0 |
| May | 6 | 3 | 0 | 0 | 0 | 0 |
| June | 24 | 6 | 0 | 0 | 0 | 0 |
| July | 49 | 9 | 0 | 0 | 0 | 0 |
| August | 43 | 10 | 0 | 0 | 0 | 0 |
| September | 13 | 10 | 0 | 0 | 0 | 0 |
| October | 0 | 0 | 0 | 0 | 0 | 0 |
| November | 0 | 0 | 0 | 0 | 0 | 0 |
| December | 0 | 0 | 0 | 0 | 0 | 0 |

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[1] California Air Resources Board, California Air Quality Data, February 1973.

[2] Federal standard for oxidant is 0.08 PPM (one-hour average).

[3] Federal standard for carbon monoxide is 9 PPM (eight-hour average).

[4] California standard for nitrogen dioxide is 0.25 PPM (one-hour average).

## TABLE 4

## SUMMARY OF MEASUREMENTS OF SUSPENDED PARTICULATES FOR SELECTED BAY AREA STATIONS, 1972*

| Station | Total Number of Samples | 260 mg**/m$^3$ | 150 mg/m$^3$*** | 100 mg****/m$^3$ |
|---|---|---|---|---|
| San Francisco | 125 | 0 | 0 | 2 |
| Stockton | 56 | 0 | 6 | 22 |
| Pittsburg | 130 | 0 | 0 | 3 |

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*California Air Resources Bureau, California Air Quality Data, February 1973.

**Federal primary standard (24-hour sample).

***Federal secondary standard (24-hour sample).

****California state standard (24-hour sample).

asparagus, 750 tons; grapes, 2,000 tons; and small grains (barley, corn, milo, oats, wheat, safflower), 9,000 tons. A limited amount of land is set aside for equipment storage and maintenance yards, roads, drainage ditches, residences, etc. The major island structures are located along the 14-mile levee road on the island's perimeter.

Recreational use is restricted on the island, but the adjacent waterways provide considerable recreation for fishermen and pleasure boaters. Extensive marina facilities are located along nearby Bethel Island, west of Mandeville Island.

### 9. Socioeconomic Setting

There are approximately 30 full-time workers on the island and 50 year-round residents, most of whom are Spanish-speaking. Many of the higher paid employees work on the island and live in Stockton. During harvest season, a maximum of 400 transient laborers work on the island. Resident children are bussed to Holt Elementary School near Holt or attend Tracy High School.

There is one residence near the levee test site and three labor camp structures and an unused schoolhouse about a mile away. Mandeville Island has a current market value of approximately $1,000 per acre.

### 10. Utilities

Electricity is supplied to the island by Pacific Gas and Electric, with telephone service provided by Pacific Telephone and Telegraph. Domestic water is from standard two-inch cased wells located on the island, while agricultural water is drawn from adjacent waterways.

### 11. Transportation

Access to the island is available by land or water. Land access is via State Highway 4 and Bacon Island and then along the levee to the Mandeville Island bridge. Traffic on Mandeville Island is currently restricted to the island owner, farm laborers and equipment and occasional sightseers. The levee road is occasionally closed to traffic during the winter due to deep mud. Boat access is available along the margins of the island except where levee maintenance operations have rip-rapped the shoreline, making boat landing hazardous.

## 12. Special Problems

### a. Levee Instability

As the soil surface has subsided, the levees, built to protect the island from flooding, have lost the buttressing support of peat soils on the inside. In addition, dredged river sediments have been used to strengthen the levees. The added weight of these sediments has compressed the underlying peat foundations, causing levee settlement and cracking.

Mandeville Island last flooded in 1937 when a combination of wave erosion, river flooding and high tide caused a stretch of levee on the island's western side to fail. The levees are more precarious today than they were in 1937. If the soil loss is not stopped or reversed, the levee's stability and ability to protect the island will diminish even further.

### b. Land Subsidence

Since its reclamation between 1916 and 1920, the surface of Mandeville Island has been lowered between 15 and 20 feet. At the test levee site the landward base of the levee is 11 feet below the high tide line and 15 feet below the crest of the levee, as shown in Figure 10.

### c. Water Quality

In a complex integrated aquatic ecosystem like the Delta, any significant water quality problems would tend to be felt throughout the entire system rather than isolated to a particular area. Thus, the water quality of the waterways around Mandeville Island is best understood by discussing the problems confronting the entire Delta.

Large-scale human endeavors (i.e., hydraulic mining in the Sierra foothills), land reclamation and diversion of water have drastically altered the aquatic environment. The water quality has obviously been altered in relation to these uses. However, the Delta waters still serve a multiplicity of uses.[1]

Present factors which diminish the water quality of the Delta are the diversion of flow from the Delta and possible saltwater intrusion, pollutants contained in irrigation drainage water from the islands, waste from recreational boats, municipal wastes and some industrial waste in the western area of the Delta. By far the most crucial problems are saltwater intrusion and irrigation drainage.

When saline water moves into the Delta, water quality diminishes, primarily because saline water is unsuitable for present uses such as domestic water supplies and irrigation. Saltwater intrusion into the Delta can occur for a variety of reasons, principally from a reduction inflow. It is estimated that the annual water supply to the Delta and upper Bay was originally 30 million acre-feet per year. In accordance with future water plans, this would be reduced from the present 18 million acre-feet per year to 7 million acre-feet per year by the year 2020, with a minimum of 1,300,000 acre-feet per year in a critical year.[2] Other factors, such as the 1972 Andrus Island levee break, also cause saline intrusion. As a result of this break, there was a substantial intrusion of saline waters into the western, central and eventually southern portions of the Delta. Under normal conditions, the intrusion can be discernible as far into the Delta as Mandeville Island.

Over 400,000 acres of Delta island land are under intensive cultivation. This reclaimed land is below the adjacent water levels, and drainage ditches and pumping stations are required to pump water back over the levees. This irrigation drainage water contains variable amounts of fertilizers, pesticides and mineral salts left in the soil by the evaporation of water during the growing season and leached out into the drainage system by rains and intentional flooding of the land in winter.[1]

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[1] California Department of Water Resources, Delta and Suisun Bay Water Quality Investigation, Bulletin No. 123, August 1967, pp. 3-8.

[2] Board of Supervisors, Contra Costa County, Statement of the Board of Supervisors of Contra Costa County, Ex-Officio Governing Board of the Contra Costa County Water Agency Regarding "The Andrus Island Levee Break," September 27 and 28, 1972, p. 13.

Previous and ongoing water quality investigations have provided extensive background information on Delta waters.[2] Water quality monitoring has been carried out by the California Department of Water Resources and the U.S. Bureau of Reclamation. This information has been published in the "Delta and Suisun Bay Water Quality Investigation" (Department of Water Resources, 1967) and subsequent yearly progress reports.[3] The present monitoring program is required under the State Water Resources Control Board Decision 1379. The program is formulated after a 1970 study and is continually expanding as manpower and equipment become available.[4]

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[1] Frank Stead, Proposed Water Quality Monitoring for the Bay Delta Resource Recovery Demonstration Project, September 18, 1973, p. 1.

[2] California Department of Water Resources, Delta and Suisun Bay Water Quality Investigation, Bulletin No. 123, August 1967.

[3] Conversation with Jerry Cox, Chief, Delta Branch, Central District, California State Department of Water Resources.

[4] California State Water Resources Control Board, An Environmental Monitoring Program for the Sacramento-San Joaquin Delta and Suisun Bay, Publication No. 40, May 1970, and conversation with Cecil Morton, Environmental Specialist, California State Water Resources Control Board.

The Bureau of Reclamation maintains three surveillance stations near Mandeville Island and have data from these stations on a wide diversity of water quality characteristics; e.g., pesticides, heavy metals, nutrients and other chemical and physical factors. This data is retained within the STORET system (the national water quality information and retrieval system).

Intermittent studies of the irrigation and drainage waters have also been made. Irrigation water quality is highest during the winter due to greater waterflows through the Delta. Drainage water quality varies seasonally, being lowest in the winter when the mineral salts are leached out of the soils. Other observed characteristics of the drainage waters, in addition to containing high levels of pesticides (soil fumigants and insecticides), herbicides and fertilizers, are that they vary considerably in relation to the quality of the supply water and that they have a high BOD (biological oxygen demand).[1]

Although water quality problems exist in the Delta, the potential for further degradation also exists. Further diversion of inflow to the Delta and increased development and subsequent water reduction in the Central Valley could have far-reaching environmental effects not immediately discernible or limited only to the Delta area.[2]

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[1] California Department of Water Resources, Delta and Suisun Bay Water Quality Investigation, p. 120.

[2] California State Water Resources Control Board, An Environmental Monitoring Program for the Sacramento-San Joaquin Delta and Suisun Bay, p. 11.

## C. BERKELEY

### 1. Land Use

The Berkeley City Planning Department is currently undertaking a survey to determine which sites would be most advantageous for the location of a transfer station. Although the proposed West Berkeley Industrial Park specifically restricts refuse processing facilities, the remainder of the area between Emeryville and Albany and between the Eastshore Freeway and San Pablo Avenue is zoned M (manufacturing) and should allow solid waste processing.

The existing landfill site at the north waterfront is the proposed location for the composting operation. According to the present Berkeley Master Plan, the area will eventually be used for parks and recreation. The site is owned by the city and is in an unclassified zone (no use permit can be granted without a change in zoning status). The city departments of Recreation and Parks, Public Works and Planning are cooperating in the final planning and development of this area, and shaping of the already filled land on the southern portion has begun. The site proposed for the composting operation is on the north or active portion of the landfill. The composting operation was defined by the City Council as an appropriate temporary land use.

### 2. Geology, Soils and Seismicity

The composting site would be located on previously filled land adjacent to San Francisco Bay at an elevation of about 12 feet (above mean sea level). The site is located over a large westward sloping alluvial fan which is composed of sediments eroded from the Berkeley Hills. These deposits were laid down in typical alluvial fan fashion by intermittent streams as they migrated back and forth across the fan surface. The terrain surrounding the site is nearly flat. Maximum local relief is 20 feet.

The site is composed of fill less than 25 years old. This fill is resting upon a sequence of geologically recent San Francisco Bay mud and other fine-grained sediments. The soil-like materials at the surface are the product of landfilling operations carried out since 1964. Although these materials are capable of supporting plant life, no true soil profile exists.

The Berkeley composting site is in a seismically active area, as is most of the California coastal region. The San Andreas fault zone lies 17 miles to the southwest, and the Berkeley-Hayward and Calaveras fault systems lie 1.7 miles and 11 miles to the northeast, respectively. No known faults pass directly through the site.

According to California Department of Water Resources literature, between 1934 and 1961 twelve earthquakes of Richter magnitude 4.0 or greater were recorded having epicenters within 20 miles of the site, as follows:

| Place Name | Month-Year | Magnitude |
|---|---|---|
| Montclair | March 1937 | 4.5 |
| San Leandro | December 1942 | 4.3 |
| East Oakland | October 1952 | 4.2 |
| Albany | October 1952 | 4.0 |
| San Leandro | December 1954 | 4.5 |
| Concord | October 1955 | 5.4 |
| South San Francisco | March 1957 | 4.4 |
| Daly City | March 1957 | 4.0 |
| Daly City | March 1957 | 5.3 |
| Gulf of Farallones | March 1957 | 4.2 |
| Concord | May 1958 | 4.1 |
| Gulf of Farallones | December 1958 | 4.7 |

In addition to the magnitude 8.3 earthquake in 1906 centered at Olema, four major earthquakes were observed nearby on these fault systems in the nineteenth century. Two were estimated at magnitude 7 on the Berkeley-Hayward fault, one at magnitude 7 on the San Andreas,[1] and another of unestimated magnitude on the Calaveras.

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[1] California Division of Mines and Geology, Crustal Movement Investigations in California: Their history, data and significance, Special Publication 37, 1972, p. 2.

## 3. Vegetation and Wildlife

Vegetation in the proposed Berkeley composting site reflects the disturbed nature of the area. Past and present refuse disposal activities are continually resulting in the dumping, leveling and subsequent disruption of onsite vegetation. Therefore, the vegetation is maintained at a disturbed and early successional condition, preventing the establishment of woody species. The majority of plant species present consists of species capable of tolerating a regime of continual disturbance, mainly annual grass and herbs of exotic origin. Mustards, mallows, yarrow, dandelion, plantain, thistles and grasses of the bromegrass, ryegrass, oats and fescue genera represent the most common plants.

Wildlife is equally restricted by the land dumping and leveling and appears to be limited largely to exotic introductions such as the Norway rat and the black rat, and other opportunistic scavengers such as the resident western gull, the wintering herring gull and California gull. Less commonly observed gulls are the ring-billed gull and the glaucus-winged gull. Populations of the deermouse and the meadow mouse may be established temporarily but are sooner or later eliminated by refuse dumping. The only other mammals of significance that may occasionally occupy the area include the raccoon, black-tailed jackrabbit and the house mouse.

No amphibians would be expected to occur at this site. The area is of marginal value to a few reptiles, possibly including the western fence lizard, alligator lizard, ringneck snake and the common garter snake. No snakes or lizards were observed during field investigations.

Adjacent open water areas are used by pelicans, cormorants, loons, scaup and other diving ducks and by mergansers and coot for feeding and resting purposes. A wide variety of shorebirds feed and rest on tidal flats, a mile from the composting site on the southeast portion of the peninsula.

## 4. Climate and Air Quality

The climate of Berkeley is greatly influenced by marine air which flows through the Golden Gate. Cool air is drawn through the Golden Gate by the pressure differential set up by the large temperature difference existing between the ocean and the Central Valley.

Berkeley has a marine climate and has weather characteristic of California coastal regions. Rain occurs mainly in the winter months, while summers are cool and dry. Temperatures are mild, with September being the warmest month (Table 5).

Winds are generally westerly, reflecting Berkeley's position with respect to the Golden Gate gap. The presence of the East Bay hills causes a split in westerly flow through the Golden Gate, and this divergent windfield causes diminished winds over the Berkeley area.

Air quality is monitored near the Berkeley area at Richmond, approximately six miles northeast of the project site. A summary of air quality data is given in Table 6.

Air quality in the Berkeley area varies greatly with weather conditions. In general, Berkeley is well ventilated. However, under calm conditions when an elevated inversion is present, photochemical oxidant smog is produced and trapped against the East Bay hills, causing significant values of photochemical oxidant over Berkeley. In addition, carbon monoxide concentrations can reach high levels under calm air conditions and surface inversion conditions, which occur mainly in fall and winter months.

## 5. Visual Quality and Noise

The Berkeley composting site is on a typical San Francisco Bay landfill. Due to current filling operations, large mounds of earth, concrete and dredging spoils dominate the site. The continual disturbance allows growth of only sparse vegetation. Thus, the site in its present state is not visually attractive.

## TABLE 5

## CLIMATOLOGICAL DATA FOR BERKELEY

### Rainfall and Temperature[1]

| | Rainfall (Inches) | Mean Max. Temp. (°F) | Mean Min. Temp. (°F) | Mean Temp. (°F) |
|---|---|---|---|---|
| January | 4.68" | 55.3° | 42.2° | 49.4° |
| February | 3.91 | 58.5 | 44.6 | 51.9 |
| March | 3.19 | 61.1 | 45.8 | 54.0 |
| April | 1.68 | 63.9 | 47.7 | 55.9 |
| May | 0.81 | 66.0 | 49.9 | 58.3 |
| June | 0.18 | 69.4 | 52.4 | 61.0 |
| July | 0.01 | 69.5 | 53.7 | 61.5 |
| August | 0.04 | 69.1 | 54.1 | 61.6 |
| September | 0.22 | 71.2 | 54.5 | 63.4 |
| October | 1.17 | 69.2 | 52.3 | 61.3 |
| November | 2.19 | 63.3 | 47.9 | 56.2 |
| December | 4.30 | 56.7 | 43.6 | 51.2 |

### Wind Direction[2] (% of time)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| N | 4.6% | E | 2.2% | S | 4.4% | W | 22.1% |
| NNE | 1.0 | ESE | 3.1 | SSW | 3.1 | WNW | 9.3 |
| NE | 1.1 | SE | 5.2 | SW | 8.0 | NW | 8.0 |
| ENE | 0.6 | SSE | 2.7 | WSW | 9.2 | NNW | 4.8 |

### Windspeed (% of time)

| 0-3 MPH | 4-10 MPH | 11-20 MPH | 21-30 MPH | Over 30 |
|---|---|---|---|---|
| 16% | 45% | 33% | 5% | 1.6% |

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[1] U.S. Department of Commerce, Climatography of the United States, No. 86-4, 1972.

[2] California Department of Water Resources, "Office Report on Wind in California," August 1960 (data for Alameda Naval Air Station).

## TABLE 6

## OCCURRENCES OF POLLUTANT CONCENTRATIONS EXCEEDING AIR QUALITY STANDARDS AT RICHMOND, 1972[1]

| | Pollutant | | | | | |
|---|---|---|---|---|---|---|
| | Oxidant[2] | | Carbon Monoxide[3] | | Nitrogen Dioxide[4] | |
| | Hours | Days | Hours | Days | Hours | Days |
| January | 0 | 0 | 0 | 0 | 0 | 0 |
| February | 1 | 1 | 9 | 2 | 0 | 0 |
| March | 3 | 3 | - | - | 0 | 0 |
| April | 5 | 2 | - | - | 0 | 0 |
| May | 0 | 0 | - | - | 0 | 0 |
| June | 4 | 1 | - | - | 0 | 0 |
| July | 3 | 2 | - | - | 0 | 0 |
| August | 0 | 0 | - | - | 0 | 0 |
| September | 7 | 3 | - | - | 0 | 0 |
| October | 0 | 0 | - | - | 0 | 0 |
| November | 0 | 0 | - | - | 0 | 0 |
| December | 0 | 0 | - | - | 0 | 0 |

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[1] California Air Resources Board, California Air Quality Data, February 1973.

[2] Federal standard for oxidant is 0.08 PPM (one-hour average).

[3] Federal standard for carbon monoxide is 9 PPM (eight-hour average).

[4] California standard for nitrogen dioxide is 0.25 PPM (one-hour average).

Impressive views are obtained from the site, however, including the Berkeley and Richmond hills to the east and north, and San Francisco, the Golden Gate Bridge and the Marin hills to the west. Southern views are partially blocked by the hotel complex located directly to the south of the site. Most of the noise on the site is from the wind, the nearby freeway and onsite fill vehicles.

## 6. Utilities

Water for Berkeley is supplied by the East Bay Municipal Utility District (EBMUD). The only source of water for the composting site is a 12-inch watermain located 1,200 feet southwest of the site, at the end of Spinnaker Road.

Electrical power is supplied to Berkeley by Pacific Gas and Electric Company. The nearest power line to the proposed composting site is located about 200 feet southeast of the site. The line is underground and surfaces adjacent to the Berkeley landfill site office.

## 7. Socioeconomic Setting

Both proposed sites for the Demonstration in Berkeley are located in Census Tract 4220, which extends from the Albany boundary on the north to the Emeryville border on the south along the Bayshore Freeway. Within the census tract, industrial development clusters near the Bayshore and residential development near San Pablo Avenue. Of a total labor force of 532 residents, 13.7% were unemployed in 1970. The 1970 census indicates a large black minority in the tract (29.5%), with a median income ($7,382) well below that for the city ($9,987). A statistical outline of the tract and Berkeley west of San Pablo Avenue is presented in Table 7.

Berkeley is the fourth largest municipality in the San Francisco-Oakland Statistical Municipal Study Area with a 1970 population of 116,716. The city has a black minority (23.5%). Of a total labor force of 30,780 in 1970, there was an 8.5% unemployment rate in the civilian labor force.

TABLE 7

## BERKELEY NEIGHBORHOOD AND CITY-WIDE CHARACTERISTICS

| | Census Tract 4220 | Berkeley West of San Pablo 4220, 21, 32 | Berkeley |
|---|---|---|---|
| Total population | 2,425 | 8,330 | 116,716 |
| Black population | 29.5% | 56.1% | 23.5% |
| Spanish-speaking population | 12.7% | 12.6% | 4.2% |
| Total households | 579 | 2,034 | 24,703 |
| Persons per household | 3.01 | 2.87 | 2.32 |
| Median school years | 13.5 | 12.6* | 12.9 |
| Employed in professional or managerial positions | 37.7% | 20.0% | 43.0% |
| Median family income | $7,382 | $7,727* | $9,987 |
| Families with income below poverty | 12.5% | 16.6% | 10.6% |
| Total housing units | 722 | 2,971 | 47,365 |
| Average number of persons per unit | 3.14 | 2.80 | 2.61 |
| Same housing unit since 1965 | 51.7% | 55.1% | 38.0% |
| Units owner-occupied | 125 | 668 | 14,036 |
| Units renter-occupied | 585 | 758 | 26,671 |
| Median value homes | $15,400 | $16,400* | $26,600 |
| Median contract rent | $72 | $94* | $128 |
| Total labor force | 532 | 1,886 | 30,780 |
| Unemployed civilian labor force | 13.7% | 11.6% | 8.5% |

*These figures are calculated as weighted average median; i.e., % population in each census tract as total of West Berkeley x median for that census tract.

Sources: U. S. Department of Commerce, 1970 Census of Population and Housing, SMSA, San Francisco-Oakland, California, PHC (1) - 189, April 1972, and Planning Department, Berkeley Facts, 1971.

## TABLE 8

## LABOR FORCE CHARACTERISTICS OF BERKELEY POPULATION BY INDUSTRY

| | 1960[1] | 1970[2] |
|---|---|---|
| Mining | 52 | -[3] |
| Construction | 1,540 | 1,374 |
| Manufacturing | 6,367 | 4,895 |
| Transportation, communications and utilities | 2,594 | 2,699 |
| Wholesale trade | 1,162 | 1,011 |
| Retail trade | 4,925 | 5,574 |
| Business, repair and personal services | 3,418 | 4,473 |
| Private households | 1,836 | - |
| Hospitals and education | 10,913 | 17,014 |
| Professions and public administration | 7,694 | 9,491 |
| Finance, insurance and real estate | -[3] | 2,748 |
| Other | 6,462 | 1,283 |
| Total | 46,963 | 50,562 |

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[1] Berkeley Planning Department, Berkeley Facts, 1971 Employment Statistics, p. 20.

[2] U.S. Department of Commerce, Bureau of Census, "Labor Characteristics Table," 1970, p. 3.

[3] Included in "Other" category.

As shown in Table 8, total employment in Berkeley in 1960 was 46,963.[1] Employment in manufacturing was 6,367 and in wholesale trade, 1,162.[2] In 1970 the total employment increased to 50,562, while manufacturing and wholesale trade employment declined to 4,895 and 1,011, respectively.[3] All other industries, except construction employment, increased in 1970.

## 8. Existing Solid Waste Operations

Berkeley's Department of Services is responsible for the collection and disposal of municipal solid wastes. An average of approximately 150 tons per day is collected and deposited at the Berkeley landfill site. The Class II landfill site (no hazardous wastes are accepted) is owned by the City of Berkeley and leased to the Berkeley Landfill Company. Only one-third of all solid wastes deposited onsite are collected by the Department of Services. The remaining two-thirds is brought by private collectors and individuals, many from outside the Berkeley area. The total site area of 40 acres is projected to be filled in four-five years.

Recycling stations receive cans and bottles at several locations throughout the city and monthly curbside collection of newspapers recently began. A recent survey indicated that 37% of all Berkeley's newspapers are being collected for recycling. As a result of education and recycling programs, Berkeley refuse collected by city vehicles declined by as much as 8,858 tons between 1969 and 1973.

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[1] Berkeley Planning Department, Berkeley Facts, 1971, p. 20.

[2] Ibid.

[3] U.S. Department of Commerce, Bureau of Census, "Labor Force Characteristics Table," 1970, p. 3.

### 9. Traffic

Currently refuse collection requires 46 packer truck trips per day, Monday through Friday, and 6 trips on Saturday to deliver refuse to the landfill site. The trucks travel on University and Gilman streets to cross the freeway to the landfill site, a distance of about four miles from the center of Berkeley. On weekends, approximately 600 vehicles, including private automobiles and commercial trucks, deliver refuse to the landfill site.

## D. SIERRA POINT

### 1. Location, Land Use and Zoning

The proposed Sierra Point composting site is on an unused 25-acre parcel of land owned by the Sanitary Fill Company. The land is zoned M2, manufacturing, where heavy industry is permitted on a minimum of one-acre parcels.

A deepwater channel borders the site on the south and would provide barging access. Neighboring operations include the American Bridge Division of U.S. Steel and Healy-Tibbitts Construction Company which use the channel for barging.

The City of South San Francisco owns the marina to the southeast of the site and is anticipating expansion of its facilities.

### 2. Geology, Soils and Seismicity

The site is composed of fill less than seven years old. This fill is resting on a sequence of geologically recent San Francisco Bay mud and other fine-grained sediments.

The soil-like materials at the surface of the Sierra Point site are the product of land filling operations between 1966 and 1970.[1] Although these materials are capable of supporting plant life, no true soil profile exists. Profiles develop over time in response to precipitation and the action of soil organisms. The end result is a layered lithic material in which particular chemical constituents are concentrated at each of several levels.

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[1] Mr. Wayne Trewhitt, personal communication, November 1973.

The site is in a seismically active area, as is most of the California coastal region. The San Andreas fault zone lies five miles to the southwest, and the Berkeley-Hayward and Calaveras fault systems lie 15 miles and 23 miles to the northeast, respectively. Splinter faults, or parallel offshoots from the San Andreas, pass within two miles of the site on the southeast and northwest sides. No known faults pass directly through the site.

According to California Department of Water Resources literature, between 1934 and 1961 eleven earthquakes of Richter magnitude 4.0 or greater were recorded having epicenters within 20 miles of the site, as follows:[1]

| Place Name | Month-Year | Magnitude |
|---|---|---|
| Montclair | March 1937 | 4.5 |
| Half Moon Bay | October 1942 | 4.3 |
| San Leandro | December 1942 | 4.3 |
| East Oakland | October 1952 | 4.2 |
| Albany | October 1952 | 4.0 |
| San Leandro | December 1954 | 4.5 |
| South San Francisco | March 1957 | 4.4 |
| Daly City | March 1957 | 4.0 |
| Daly City | March 1957 | 5.3 |
| Gulf of Farallones | March 1957 | 4.2 |
| Gulf of Farallones | December 1958 | 4.7 |

### 3. Vegetation and Wildlife

The vegetation is typically that of a highly disturbed site and is largely composed of species characteristic of the early stages of secondary succession. Large expanses of bare or almost bare ground are interspersed with isolated pockets of low-growing vegetation. Plant colonization is severely limited by unfavorable soil moisture conditions during the summer and by the high gravel content and discontinuous soil layer of the landfill. Vegetational growth is highly seasonal and annuals predominate.

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[1] California Department of Water Resources, Crustal Strain and Fault Movement Investigation, Faults and Earthquake Centers in California, Bulletin No. 116-2, January 1964, p. 61.

Most plants are introduced or exotic species, including patchy stands of wild oats, Bromus species, several mustards including wallflower, pampas grass and thistles. The only woody vegetation present is several small individuals of coyote brush. A narrow and limited expanse of pickleweed occupies the bay edge of the landfill.

The site apparently supports no resident wildlife populations because of the general lack of adequate year-round food and cover. Certain opportunistic species utilize the area during periodic foraging visits, and these have been generally classified as low successional species.[1]

Among birds, starlings, Brewer's blackbirds, gulls and rufous-crowned and white-crowned sparrows have been observed. Although field visits have not been conducted during all seasons of the year, it is certain that species density and diversity are extremely low. Use of the site by resident birds is largely precluded due to the general absence of nesting cover and a limited supply of food. Ground-feeding passerines are probably the most common group intermittently visiting the site. Some waterbirds and shorebirds appear to use the offshore and shoreline areas, respectively, but densities are obviously low.

No mammals were observed during the field visit, and any use of this site would probably be extremely periodic and variable. Small mammals could occupy the area for only a few months of the year (during late winter when food and cover are most available).

Use is further restricted by the general lack of potential emigration sources in the immediate vicinity. It is also unlikely that any mammals occupy the pickleweed areas. Among larger mammals, the area may be occasionally visited by such species as the bushrabbit or raccoon.

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[1] R. F. Dasmann, Wildlife Biology (New York: John Wiley & Sons, 1964).

Environmental conditions are considered to be too harsh for all amphibians and most reptiles, although the western fence lizard may be present.

In conclusion, the wildlife of this site is extremely limited in abundance and diversity and appears to consist almost solely of visiting individuals, since the very low and seasonally varying carrying capacity apparently cannot support resident populations at the present time. Additional factors contributing to the situation are the presence of a major freeway which acts as a barrier to the movement of terrestrial species, and the prevalence of industrial development in the general vicinity.

### 4. Climate and Air Quality

The climate at Sierra Point is greatly influenced by the proximity of the Pacific Ocean and the general topography of the Bay Area with respect to the great interior valley. The summer buildup of the Pacific high-pressure cell, along with the associated increase of northwesterly flow along the California Coast and the resulting upwelling of cold water, results in great temperature differences between the coast and the interior. Airflow into the interior valley, however, is restricted by coastal mountains except in the vicinity of San Francisco northwest of South San Francisco where the San Bruno gap allows cool marine air to flow over the mountains.

This influx of marine air provides Sierra Point with a marine climate, characterized by mild, moderately wet winters and cool, dry summers. Table 9 shows that three-fourths of the rainfall occurs in the winter months, with practically no rain during the summer months. Temperatures at South San Francisco are mild and have relatively small daily and annual ranges. Highest temperatures occur in September, when the sea breeze becomes less pronounced.

The position of the project site relative to the San Bruno gap strongly influences wind direction and speed. The proposed site is at the extreme east end of Mount San Bruno and therefore shielded from the main flow of air through the San Bruno gap. Winds at the proposed site are slower and more southerly than winds measured at the San Francisco

## TABLE 9

## CLIMATOLOGICAL DATA FOR SOUTH SAN FRANCISCO

### Rainfall and Temperature[1]

| | Rainfall (Inches) | Mean Max. Temp. (°F) | Mean Min. Temp. (°F) | Mean Temp. (°F) |
|---|---|---|---|---|
| January | 4.01" | 55.8° | 40.5° | 48.6° |
| February | 3.48 | 58.7 | 42.6 | 50.9 |
| March | 2.69 | 61.3 | 44.5 | 53.3 |
| April | 1.30 | 63.0 | 46.2 | 55.7 |
| May | 0.48 | 65.5 | 48.9 | 58.3 |
| June | 0.11 | 68.9 | 51.3 | 61.3 |
| July | 0.01 | 70.0 | 52.4 | 62.7 |
| August | 0.02 | 70.2 | 52.5 | 62.8 |
| September | 0.19 | 72.5 | 52.4 | 63.9 |
| October | 0.74 | 69.8 | 49.7 | 60.5 |
| November | 1.57 | 64.0 | 44.5 | 54.8 |
| December | 4.09 | 57.3 | 42.0 | 50.1 |

### Wind Direction[2] (% of time)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| N | 1.3% | E | 2.9% | S | 3.3 | W | 18.7 |
| NNE | 1.2 | ESE | 2.6 | SSW | 2.9 | WNW | 21.5 |
| NE | 2.8 | SE | 4.3 | SW | 4.8 | NW | 14.2 |
| ENE | 2.5 | SSE | 2.6 | WSW | 5.4 | NNW | 1.6 |

### Windspeed (% of time)

| 0-3 MPH | 4-10 MPH | 11-20 MPH | 21-30 MPH | Over 30 |
|---|---|---|---|---|
| 16% | 28% | 38% | 16% | 2% |

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[1] U.S. Department of Commerce, *Climatography of the United States*, No. 86-4, 1972.

[2] California Department of Water Resources, *Office Report on Wind in California*, August 1960.

Airport, due to divergence as the airstream flows around the mountain. Winds during the summer are generally strong and westerly; during the winter both wind speed and direction are more variable.

Air quality at Sierra Point is generally good compared to the remainder of the Bay Area, since the moderate wind speeds result in considerable dilution of pollutants horizontally. The marine inversion, however, is quite persistent in the area, and high pollutant levels can be realized whenever the wind is light.

Air quality data for two neighboring air quality monitoring stations, San Francisco and Burlingame, are given in Tables 10 and 11. The San Francisco air quality monitoring station is located approximately eight miles northwest of the project site, in downtown San Francisco. Burlingame is a residential area located approximately seven miles southeast of the project site. These tables indicate that pollutant concentrations at these stations seldom exceed the existing standards. Significant concentrations of photochemical oxidant occur mainly during the summer, under conditions of bright sun and a strong marine inversion. Carbon monoxide, however, occasionally reaches high concentrations in the winter, when surface-based inversions trap auto emissions near the ground. Nitrogen dioxide is rarely a problem at either monitoring station.

## 5. Visual Quality and Noise

The Sierra Point site has very little diversification. Low, sparse vegetation and the absence of man-made structures contribute to the barren atmosphere.

Because the site was recently filled, it is not a natural area and thus has little scenic value. Offsite views include those of an active landfill site to the north, an industrial park and shipping channel to the south, San Francisco Bay to the east and the Bayshore Freeway and San Bruno Mountain to the west.

Noise is created primarily by the freeway near the site. Odors can be detected from gases escaping from the underlying fill, particularly after rains.

## TABLE 10

## OCCURRENCES OF POLLUTANT CONCENTRATIONS EXCEEDING AIR QUALITY STANDARDS AT SAN FRANCISCO, 1972[1]

| | Pollutant | | | | | |
|---|---|---|---|---|---|---|
| | Oxidant[2] | | Carbon Monoxide[3] | | Nitrogen Dioxide[4] | |
| | Hours | Days | Hours | Days | Hours | Days |
| January | 0 | 0 | 21 | 2 | 0 | 0 |
| February | 0 | 0 | 0 | 0 | 0 | 0 |
| March | 0 | 0 | 35 | 4 | 0 | 0 |
| April | 0 | 0 | 0 | 0 | 0 | 0 |
| May | 0 | 0 | 0 | 0 | 0 | 0 |
| June | 0 | 0 | 0 | 0 | 0 | 0 |
| July | 0 | 0 | 0 | 0 | 3 | 2 |
| August | 0 | 0 | 0 | 0 | 0 | 0 |
| September | 0 | 0 | 0 | 0 | 0 | 0 |
| October | 0 | 0 | 12 | 2 | 0 | 0 |
| November | 0 | 0 | 8 | 2 | 0 | 0 |
| December | 0 | 0 | 8 | 2 | 0 | 0 |

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[1] California Air Resources Board, California Air Quality Data, February 1972.

[2] Federal standard for oxidant is 0.08 PPM (one-hour average).

[3] Federal standard for carbon monoxide is 9 PPM (eight-hour average).

[4] California standard for nitrogen dioxide is 0.25 PPM (one-hour average).

## TABLE 11

## OCCURRENCES OF POLLUTANT CONCENTRATIONS EXCEEDING AIR QUALITY STANDARDS AT BURLINGAME, 1972[1]

| | Pollutant | | | | | |
|---|---|---|---|---|---|---|
| | Oxidant[2] | | Carbon Monoxide[3] | | Nitrogen Dioxide[4] | |
| | Hours | Days | Hours | Days | Hours | Days |
| January | 0 | 0 | 11 | 2 | 0 | 0 |
| February | 0 | 0 | 0 | 0 | 0 | 0 |
| March | - | - | - | - | 0 | 0 |
| April | 2 | 1 | 0 | 0 | 0 | 0 |
| May | 10 | 3 | 0 | 0 | 0 | 0 |
| June | 3 | 2 | 0 | 0 | 0 | 0 |
| July | 10 | 3 | 0 | 0 | 0 | 0 |
| August | 0 | 0 | 0 | 0 | 0 | 0 |
| September | 0 | 0 | 0 | 0 | 0 | 0 |
| October | 9 | 2 | 0 | 0 | 0 | 0 |
| November | 0 | 0 | 0 | 0 | 0 | 0 |
| December | 0 | 0 | 12 | 1 | 0 | 0 |

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[1] California Air Resources Board, California Air Quality Data, February 1973.

[2] Federal standard for oxidant is 0.08 PPM (one-hour average).

[3] Federal standard for carbon monoxide is 9 PPM (eight-hour average).

[4] California standard for nitrogen dioxide is 0.25 PPM (one-hour average).

## 6. Utilities

At present there are no utility lines for electricity, gas, water or telephone near the compost site.

## 7. Socioeconomic Setting

Sierra Point is included in Census Tract 6023, the northeastern section of South San Francisco, nearest the Bay. It has mixed industrial and residential land uses. In 1970, of the 3,169 residents in the tract, 20.7% were Spanish-speaking. There were a total of 1,210 persons employed here in 1970, 24.2% in manufacturing, 14.5% in retail trade and 13.1% in the government.

In 1970, 46,646 persons resided in South San Francisco, 16.4% of whom were Spanish-speaking. Total employment in the city was 19,496. Of this total, 20.9% worked in manufacturing, 16.9% in retail trade and 13.9% were government employees. A more detailed statistical description of the city and Census Tract 6023 is presented in Table 12.

## 8. Existing Solid Waste Operations

Municipal solid wastes in San Francisco are collected by the Sunset Scavenger and Golden Gate Disposal companies. The refuse is then taken to the transfer station which is owned and operated by SWETS (Solid Wastes Engineering Transfer Systems), located on Tunnel Avenue in San Francisco. The station receives 2,000 tons per day of refuse and has an ultimate capacity of 5,000 tons per day.

The residential portion of the wastes are processed through a hammer mill and a magnetic separator to recover ferrous metals. The remainder of the wastes are then loaded into transfer vehicles and taken 35 miles to the Mountain View Sanitary Landfill.

Bundled newspapers are collected by normal route trucks and unloaded at the transfer station for sale to a newsprint broker.

## TABLE 12

## SOUTH SAN FRANCISCO
## NEIGHBORHOOD AND CITY-WIDE CHARACTERISTICS

| | Census Tract 6023 | South San Francisco |
|---|---|---|
| al population | 3,169 | 46,646 |
| ck population | 0.1% | 1.3% |
| nish-speaking population | 20.7% | 16.4% |
| al families | 761 | 11,992 |
| sons per household | 3.46 | 3.31 |
| ian school years | 12.3 | 12.3 |
| loyed in professional or managerial positions | 4.7% | 7.1% |
| ian family income | $11,557 | $12,281 |
| ilies with income below poverty | 5.9% | 4.1% |
| al housing units | 912 | 14,283 |
| rage number of persons per unit | 3.2 | 3.1 |
| housing unit since 1965 | 53.4% | 58.7% |
| ts owner-occupied | 524 | 8,842 |
| ts renter-occupied | 323 | 4,615 |
| ian value homes | $22,500 | $26,100 |
| ian contract rent | $128 | $141 |
| al labor force | 867 | 12,864 |
| ployed civilian labor force | 8.1% | 3.9% |

rce: U.S. Department of Commerce, 1970 Census of Population and Housing, SMSA, San Francisco-Oakland, California, PHC (1)-189, April 1972.

## 9. Traffic

Route trucks deliver San Francisco refuse to the transfer station. From the transfer station 85 transfer trucks travel daily along Highway 101 (Bayshore Freeway) to the Mountain View landfill site, a distance of 35 miles each way. Vehicular traffic along the access road to Sierra Point is limited to a small number of trucks delivering clean fill to the area of Sierra Point located in Brisbane.

# V. ENVIRONMENTAL IMPACTS

## A. GEOLOGY, SOILS AND SEISMICITY

Principal geologic and soils impacts of the Demonstration upon the island test site are expected to include:

1. Horizontal reinforcement of the adjacent levee segment and concomitant reversal of the present chronic loss of organic soil to oxidation.
2. Probable transverse and longitudinal cracking or fissuring of levee surfaces.
3. Increases in the potential for undetected seepage and sand boils along the landward levee surface.
4. Concentration of nonoxidizing residue (principally plastic film) at the soil surface after several years of project operation.
5. Development of a new agricultural soil.

The principal beneficial geologic and soils impact of the project would be to provide reinforcement for part of the Mandeville Island levee system. (The problem of deteriorating levee stability is described in the section on Levee Instability.) Compost material gradually would be built into a buttressing wedge which would help to offset the horizontal pressure exerted by the river. Associated with the establishment of this wedge would be a shift in the equilibrium that exists between formation of organic soil materials and their oxidation. The clearing of native vegetation to permit farming has virtually stopped the production of peat while increasing its loss by oxidation. Compost placement would begin rebuilding soils lost through oxidation. Its application would be much like reestablishing the production of peat at an accelerated rate, and would raise the land surface at the same time.

The most important adverse soils effect of compost placement as currently proposed would be probable cracking, or fissuring, of levee surfaces. According to Duncan and Seed,[1] the placement of a thick layer of compacted compost on the landward side of a Delta levee would cause large nonuniform settlements which would probably lead to the development of cracks in the levees. This is especially true along the top and sloping inner surfaces of levees. The fissuring has been estimated to amount to as much as three feet of total separation where a 500-foot wide wedge reaching a depth of 20 feet is laid down. These tensional fissures could run across the levee at the ends of the compost berm as well as running parallel to the levee axis.

The third principal effect of compost placement is the covering of the levee slope making difficult direct detection of seepage. When water from such seepage becomes cloudy from soil particles being washed out, it is a sign of possible incipient levee failure.

Duncan and Seed point out, however, that if compost placement is done slowly (by thin layering), subdrains are installed, and if levee surfaces are carefully monitored for signs of fissuring, the chances of levee failure would be diminished but not eliminated.[2] Although the difficulty of monitoring water seepage from the levee and from the natural ground is an important problem, all possible steps would be taken to insure that the subdrain design would accommodate the seepage. At the same time, piezometers would be installed so that water pressures could be monitored to be sure that dangerous water pressures would not build up beneath the berm.

The fourth principal effect is the accumulation or concentration of slow-to-decompose material (mainly plastic film) at the soil surface. This concern is primarily aesthetic, although it could also reduce the agricultural viability of the soil surface. While this problem is worth mentioning, it is not expected to be serious for several reasons. First, although residential use of plastics has been increasing during the past decade, much of it can be screened out of composted material without technical difficulty. Second, the rate of application of compost would be much greater than the rate of oxidation at the surface so that plastics would not concentrate rapidly, at least during the period of the Demonstration. And finally, plastic film is similar in buoyancy to other light compost constituents and may be removed by the action of the wind. This could cause a littering problem, however.

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[1] J. M. Duncan and H. Bolton Seed, A Study of the Feasibility of Stabilizing Delta Levees with a Berm of Composted Municipal Waste, (see Volume III, Figure 12).

[2] Ibid., p. 15.

One of the important objectives of the Demonstration is to determine the viability of compost as a soil-like material. Compost is usually used as a soil amendment, being mixed into an existing soil at a particular number of tons per acre. This is done to improve its aeration and water-retention capacity and to add nutrients. The concept of the Demonstration is to place compost on top of the existing peat to serve as a soil by itself. Fresh compost, like virgin peat, is high in organic materials but lacks enough minerals to be a fertile soil. The compost must then be considered a parent soil material. As the organic portion of the compost decomposes, a mineral ash residue builds up, eventually reaching a fertile balance. The rate at which the fertility of the compost will develop is to be monitored during the Demonstration.

The seismic impacts of the Demonstration at the test site and Mandeville Island as a whole revolve around the question of levee stability during a major earthquake. No Delta islands were as far below sea level at the turn of the century as Mandeville Island is today. However, the fact that no levees failed during the infamous 8.3 magnitude earthquake of April 1906 has led H. B. Seed to the conclusion that the Delta peat has a limited ability to transmit or amplify earthquake shaking to overlying structures such as levees.[1] Furthermore, the relative seismic inactivity of the area, coupled with the absence of identifiable faults nearby, suggests that future seismic activity would not be great. In any event, there is no indication that the compost berm would affect the performance of the levee in an earthquake in any significant way.

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[1] H. Bolton Seed, Department of Engineering, University of California Berkeley, personal communication, October 1973.

At the Berkeley and Sierra Point composting sites, except for the covering of perhaps five acres of artificial fill soils, there will be no significant geologic hazards or soils impacts due to the Demonstration. Both involve facilities which cause minimal loading of the artificial fill soils. Soil liquefaction, or site failure under compressional shock, is the principal seismic hazard that exists at present at Berkeley and Sierra Point. This hazard would not be significantly altered by the construction and operation of the Demonstration.

## B. VEGETATION AND WILDLIFE

In view of the disturbed nature of the Berkeley and Sierra Point composting sites, the impact of the proposed composting operations on wildlife and vegetation would be slight, provided measures are implemented to prevent the excessive leaching of liquid wastes into adjacent Bay waters, and safeguards are implemented to prevent the development of a rodent pest problem. A rodent-proof containing wall would eliminate this possibility.

The presence of rich organic sludge could attract additional populations of scavenging birds, particularly gulls, but the numbers involved would be negligible, especially in comparison to those attracted to the existing landfill operation in Berkeley.

At Mandeville Island, the direct impact of the levee reinforcement program on wildlife and vegetation at the test site is considered to be negligible because of the small area involved and because of present agricultural uses. However, since the program would introduce new environmental contaminants that could conceivably leach out into local ecosystems, the indirect effects of the project are likely to be more serious and far-reaching. Adverse effects to fish and wildlife are likely to develop if sufficient quantities of pollutants leach into the surrounding aquatic systems. Contamination of the human food resources contained in fish and shellfish is also possible.

It is vital to appreciate the biological importance and fragility of freshwater and saline aquatic communities if the contamination aspect is to be placed in perspective. Estuaries support highly productive and complex biotic communities.[1] Marshes and estuaries are among the most productive biotic communities known, and the Sacramento-San Joaquin estuary is no exception.[2] As a natural system, estuaries are well known for their fragility and vulnerability to modification.[3] Estuaries serve as a nursery and feeding ground for a great variety of animals from crayfish, shellfish and crabs to fish and birds. Many fishes and birds depend on the estuary system during some or all stages of their life cycles. Estuaries are known to provide food for species that permanently reside outside the strict confines of the system, and therefore changes in the local system can induce effects in animal populations well downstream of the specific site of influence (for example, the marine ecosystem).

The likelihood of environmental contamination is impossible to predict on the basis of existing background data, and the answering of this question through an extensive monitoring program is one of the prime objectives of the Demonstration. Some of the more significant pollutants can be discussed in terms of their potential impact.

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[1] P. A. Douglas and R. H. Stroud, ed., A Symposium on the Biological Significance of Estuaries, Sport Fishing Institute, Washington, D.C., 1971.

[2] California Department of Fish and Game, Ecological Studies of the Sacramento-San Joaquin Estuary, Delta Fish and Wildlife Protection Study Report No. 8, p. 94.

[3] B. H. Ketchum, The Water's Edge--Critical Problems of the Coastal Zone (Cambridge: Massachusetts Institute of Technology, 1972), p. 393.

The major contaminants involved are polychlorinated biphenyls (PCBs), phthalate acid esters (phthalates) and heavy metals. These pollutants are well known for their persistence and wide dispersion in the physical and biotic environment, their resistance to metabolic breakdown, their affinity to living tissue, their ability to accumulate in food chains, and their toxicity to living organisms.

## Polychlorinated Biphenyls

PCBs are widely used in electrical and heat-transfer appliances, hydraulic fluids and lubricants, and household plastic articles where they are used as plasticizer agents. They are a major constituent of the polyethylene group of plastics, and until recently were widely used in food-wrapping films and containers.[1]

PCBs have been detected in sewage outfalls originating from industrial areas and soils adjacent to landfills and dumps.[2] PCBs apparently enter the environment during spills and losses during their manufacture, the vaporization and leaching from PCB-containing formulations and from the waste PCBs or PCB-containing liquids deposited in dumps or carried by sewage systems The mode of transport within the environment is extremely complex, but PCBs are generally dispersed by adsorption on airborne or waterborne particulates. They are known to diffuse through the soil, or to be transported with eroding soil particles. Bottom sediments of lakes and rivers are known to accumulate considerable quantities of PCBs with time.

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[1] I. C. T. Nisbet and A. F. Sarofim, "Rates and Routes of Transport of PCBs in the Environment," Perspective on PCBs, Environmental Health Perspectives, Experimental Issue No. 1 DHEW Publication No. (NIH) 72-218, 1972.

[2] Ibid.

Eventually, however, significant quantities of this synthetic organic compound become accumulated in animal tissues. Although PCBs are relatively insoluble in water, they are extremely soluble in fat-rich animal tissue. Through the process of biological magnification, fish and birds high in the food chain accumulate high quantities of the contaminant. PCBs are considered to be ubiquitous components of the global environment and are found in the biotic and abiotic environment far from areas of original discharge and at far higher concentrations than the surrounding medium.[1] Aquatic invertebrates and fish can accumulate PCBs to levels of 3,000 and 70,000 times higher than those in the ambient water. Significant levels have been found in marine birds that rarely approach land except to breed on isolated islands. Fish are able to concentrate PCBs to an order more than 40,000 times that of exposure levels.

PCBs have several sublethal effects on various parameters of the reproductive mechanisms of animals. Toxicity varies greatly depending on many factors such as the species, its physiological condition, mode of reproduction, diet, local environment, etc. Aquatic invertebrate reproduction can be adversely affected at concentrations of 5 mg/l or less.[2]

PCBs will be introduced to compost from urban refuse and sewage sludge. Recent analysis of a number of liquid sewage outfalls along the coast of California indicates that PCB escapement varies considerably, depending upon the original source of the treated sewage.[1] Sewage districts that encompass both urban residential and industrial areas release the largest amounts of PCBs. Thus, the East Bay Municipal Utility District's outlet was found to release two kilograms daily in the liquid component. At one San Francisco industrial outlet near the Bay Bridge, 0.6 kilograms daily were being released. The higher value of the EBMUD outlet reflects the fact that sewage is collected from the entire East Bay area. A predominantly residential area in Los Angeles produced 0.4 and 1.6 kilograms of PCBs daily in its liquid and sludge waste components, respectively. It is, therefore, possible that the PCB content of sludge wastes may exceed that of liquid wastes, at least on the basis of these samples. Evidently more research is needed to identify the expected daily input of PCBs in the sludge material used at both composting sites.

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[1] R. W. Risebrough and B. de Lappe, "Accumulation of Polychlorinated Biphenyls in Ecosystems," Environmental Health Perspectives, Volume 1, 1972, pp. 39-46.

[2] D. Stalling and F. L. Mayer, "Toxicities of PCBs to Fish and Environmental Residues," Environmental Health Perspectives, No. 1, 1972, pp. 159-164.

The amounts of PCBs introduced in the urban solid refuse component is also unknown and will depend primarily on the efficiency of the separation processes. The plastics component of urban refuse consists of 38% polyethylene, 32% polyvinyl chloride, 21% polystyrene and 9% miscellaneous plastics, like nylon and teflon.[2] In terms of PCBs, the most potentially harmful class of plastics is considered to be the polyethylene group. Since the majority of these plastics are represented by films and light containers, separation by air classification is expected to be minimal and removal must rely on screening after the composting process.[1] It is specified that a maximum of 1% of the compost material will be plastic,[2] and based on this assumption, as much as 700 tons may be introduced to the levee landfill site during the course of the project.

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[1] T. Schmidt, R. W. Risebrough and F. Gress, "Input of PCBs into California Coastal Waters from Urban Sewage Outfalls," Bulletin of Environmental Contamination and Toxicology, No. 6, 1971, pp. 235-243.

[2] N. L. Dronby, H. E. Hull and P. F. Testin, Recovery and Utilization of Municipal Solid Waste, Batelle Memorial Institute, 1971, p. 91.

The percentage of this amount that can be expected to leach out of the landfill area is unknown, but it may have significant impact. Leachate rates can only be accurately determined if the project involves a thorough monitoring program.

Phthalate Acid Esters

Phthalate acid esters are a very widely used chemical and are commonly used in the construction, clothing, food packaging, flooring, furniture and household article industries.[3] Phthalates are widely used as a plasticizer, having recently replaced PCBs. This synthetic, organic compound is a major constituent in polyvinyl chloride plastics and apparently is an important constituent of food packages, household appliances, housewares and wall coverings.

Existing information indicates that phthalates conform to the general pattern of environmental pollutants in terms of stability, distribution, metabolic breakdown and toxicity. These substances have been identified in water, organic soil matter, fish and a wide variety of animals and are considered to have a ubiquitous distribution in the environment.[1]

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[1] An electrostatic unit to separate plastics and paper has been developed in the laboratory by the U.S. Bureau of Mines. If successfully developed on a large scale, this unit could separate all plastics from the light, air classified fraction of refuse. Resource Recovery from Raw Urban Refuse, Bureau of Mines Report of Investigations 7760, 1973.

[2] S. A. Hart, A Preliminary Compost Experiment and Suggestions for Compost Specifications.

[3] P. R. Graham, "Phthalate Ester Plasticizers--Why and How They Are Used," Perspective on PAEs, Environmental Health Perspectives, Experimental Issue No. 3., DHEW Publication No. (NIH) 73-218, 1973, pp. 3-12.

Phthalates are apparently widespread in coastal waters[2] and in rivers draining industrial areas.[3] They have been detected in marine animals residing at great distances from pollution sources (for example, a deep-sea jellyfish).[4]

Phthalates are believed to be transported in a similar manner to PCBs.

There is general agreement in the literature that all phthalates studied to date have a low order of acute toxicity, but this is partly offset by the large background levels detected in many environments. Although the biological significance of phthalic acid residues are largely unknown, deleterious effects on reproduction have been observed in some aquatic organisms in laboratory experiments.[5] In some cases, concentrations of phthalates presently found in some waters of the United States are detrimental to aquatic invertebrates. Moderate levels have been found in fish near industrial reas, but considerably more detailed research is equired to identify deleterious effects in terms of ish physiology and reproduction.[1]

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[1] F. L. Mayer, D. L. Stalling and J. L. Johnson, "Phthalate Esters--An Environmental Contaminant," Nature, 1972, 238:411.

[2] E. F. Corcoran, "Gas Chromatographic Detection of Phthalic Acid Ester," Perspective on PAEs, pp. 13-16.

[3] R. A. Hites, "Phthalates in the Charles and the Merrimack Rivers," Perspective on PAEs, 1973, pp. 17-22.

[4] R. J. Morris, "Phthalic Acid in the Deep-sea Jellyfish Atolla," Nature, 1970, 227:1264.

[5] F. L. Mayer and H. O. Sanders, "Toxicology of Phthalic Acid Esters in Aquatic Organisms," Perspective on PAEs, 1973, pp. 153-157.

information is available on the amounts of phthalate hat would be introduced with the compost placement aterial. Polyvinyl chloride plastic formulations contain nearly 60% phthalate esters plasticizer content, ut the separation techniques proposed are expected to xtract essentially all of the heavier plastic components the urban refuse. Laboratory analysis of the urban efuse material after separation is the only means of edicting the probable input of phthalate compounds. rthermore the impact on biological systems can only be valuated on the basis of a thorough monitoring program.

eavy Metals

eavy trace elements are natural components of the world cosystem. Many, like zinc, copper and manganese, are nstituents of essential metalloenzymes, while others silver, lead, cadmium and mercury) have no known biogical function. Natural background levels of the eavy metals in the estuarine and marine environments are orly known, but there is widespread evidence to suggest esent amounts are higher than pre-technological levels, nd are responsible for inducing deleterious effects in any forms of wildlife, especially shellfish and fish.[2]

eavy metals are introduced into river, estuarine and astal waters via natural weathering, aerial transport, ver runoff and by local discharges of industrial and mestic waters.[3] Sewage effluents are known to contain high levels of some trace elements, and probably contribute significant amounts of toxic trace elements to California waterways and coastal waters.[1] The table of sewage sludge samples from the East Bay Municipal Utility District's treatment facility indicates high levels of aluminum, lead, chromium, tin, silver, titanium and nickel are in the sludge being deposited in landfills (see Table 13 following). It is not known whether these data necessarily reflect the typical composition of a sludge sample.

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[1] D. L. Stalling, J. W. Hogan and J. L. Johnson, Phthalate Ester Residues--Their Metabolism and Analysis n Fish," Perspective on PAEs, 1973, pp. 159-174.

[2] E. Browning, Toxicity of Industrial Metals (London: utterworths, 1969).

[3] H. J. M. Bowen, Trace Elements in Biochemistry ondon: Academic Press, 1966), p. 241.

Heavy metals exhibit the basic properties of biological pollutants, and many species are known to selectively accumulate trace elements to many times the local environmental levels. While there is little information on the background levels of most heavy metals in estuarine organisms, more is known of heavy metal toxicity. Silver, zinc, cadmium, chromium and mercury are considered to be highly toxic to living tissues, since many interfere with oxygen metabolism, cell permeability and metabolic enzyme systems.[2] A wide range of trace elements is known to form stable metalloprotein complexes that interrupt normal cell activities. Excessive concentrations of mercury have been shown to reduce the photosynthetic rate of plankton[3] and induce adverse effects in fish and fish-eating birds.[4] The impact of trace metals on

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[1] G. R. Bradford, "Trace Element in the Water Resources of California," Hilgardia 41:45-53, 1971.

[2] E. Browning, Toxicity of Industrial Metals.

[3] R. C. Harris, D. B. White and R. B. Macfarlane, "Mercury Compounds Reduce Photosynthesis by Plankton," Science, 1970:736-737.

[4] N. Fimreite, et al., "Mercury in Fish and Fish-eating Birds Near Sites of Industrial Contamination in Canada," Canadian Field Naturalist, 85:211-220.

## TABLE 13

## REPORT ON VACUUM FILTER SLUDGE CAKE

| atory Analysis | | Spectrographic Analysis mg/1000g wet sample | |
|---|---|---|---|
| | 24.4 | Sodium | ** |
| | 12.0 | Potassium | 496.0 |
| , mg/1,000g | 756 wet sample | Calcium | 7,440.0 |
| a Kjeldahl | 7,810 wet sample | Magnesium | 1,488.0 |
| ogen, mg/ 0g | (excluding nitrites and nitrates) | Silicon | principal constituent |
| a phosphate, ,000g | 11,386 wet sample | Boron | 37.2 |
| | 0.59 | Phosphorus | 4,340.0 |
| a alkalines, / | | Manganese | 124.0 |
| aCo$_3$ | -- | Iron | 8,680.0 |
| ile acid, | | Aluminum | 6,200.0 |
| / as HA$_c$ | -- | Lead | 372.0 |
| nd grease | 1.4 | Chromium | 620.0 |
| , total, / | 187,098 wet weight | Tin | 74.4 |
| , ng/L | 9,000 | Copper | 74.4 |
| | -- | Silver | 12.4 |
| n/nitrogen | 8:1 | Zinc | 744.0 |
| | | Titanium | 868.0 |
| | | Nickel | 62.0 |
| | | Strontium | 31.0 |
| | | Vanadium | 9.92 |
| | | Barium | 372.0 |
| | | Bismuth | 2.48 |
| | | Molybdenum | 6.2 |
| | | Zirconium | 37.2 |
| | | Cobalt | 4.96 |
| | | Gallium | 1.24 |

e ge of two determinations.
n interference, but approximately
.

u e: East Bay Municipal Utility
District, Sanitary District No. 1.

estuarine mollusks is complex and difficult to assess but can be deleterious.[1]

It is presently impossible to make quantitative predictions of the effect of heavy metal waste disposal in the estuarine system since there are inadequate data on the chemical and biochemical processes involved and the ecological structure of local communities.[2] Predictions will have to be based on a thorough monitoring program designed to identify background and subsequent levels of the more toxic trace elements in indicator or sensitive species.

## Conclusions

The potential introduction of environmental contaminants into the Delta waterway system represents the only significant and critical impact of the project on fish and wildlife. Several areas near Mandeville Island, including Bacon Island, Latham Slough and Middle River, support significant wildlife and fishery resources that would probably be adversely affected if substantial quantities of synthetic organic compounds and heavy metals escape from the compost placement site. Local waterways are known to constitute major nursery areas for the striped bass, a situation probably attributable to the favorable abundance of certain food species.[3]

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[1] C. N. Schuster and B. N. Pringle, "Effects of Trace Elements on Estuarine Mollusks," Proceedings of First Mid-Atlantic Industrial Waste Conference, University of Delaware, 1968, 6E-5:285-304.

[2] National Academy of Sciences, Wastes Management Concepts for the Coastal Zone--Requirements for Research and Investigation, Publication No. 15BN 0-309-01855-2.

[3] California Department of Fish and Game, Ecological Studies of the Sacramento-San Joaquin Delta, Fish Bulletin 136, 1966.

scapement of pollutants could significantly reduce the rductivity of the area.

he impact of the project will depend upon a combination f many interrelated factors, including the total amount of olutants introduced to the site, pollutant escape and istribution, and pollutant uptake rates and accumulation y biotic elements. The toxic effects of the major olutants are complex, and species response to toxiants will vary greatly with different stages in the ie history, with previous nutrition, and with season, o mention only a few factors.

he experimental situation provides an ideal opportunity o assess the effect of this form of refuse disposal, but ts success will depend upon the strength of the ongoing onitoring program. The development of adverse effects n aquatic animals should be considered a justifiable asis to terminate the program until such time "cleaner" ompost materials can be used.

## . AIR QUALITY AND ODORS

he Demonstration's effects on air quality can be classiied into three categories:

(1) Gases, odors and dust released during the composting process.

(2) Emissions from vehicles involved in the project.

(3) Dust and litter released during loading, unloading and levee reinforcement processes.

(4) Dust from wind erosion of completed compost surface.

olutants released during the composting process will ny affect the Berkeley and Sierra Point sites. Gases rduced by the composting material during aerobic decomosition consist almost entirely of carbon dioxide, a amless gas which is not normally considered a pollutant. owever, methane or hydrogen sulfide and other noxious ases could be generated in brief periods of improper peration until aerobic conditions could be restored.

At Sierra Point, the prevailing moderate windspeeds and southwesterly wind direction will rapidly dilute any odors and transport them over the Bay. A residential area is located one-half mile southwest of the site. Because the winds necessary to transport odors from the site to these areas are infrequent, and because compost is a relatively weak source of odors, no significant odor problem is expected at the Sierra Point site.

The Berkeley site has a greater potential for odor problems. Prevailing westerly winds could carry odors to residences east of the site. The nearest residence is approximately one mile east of the site, and the Berkeley Marina is located about three-fourths of a mile south of the site. However, the proposed site is presently part of the Berkeley landfill operation, which emits odors far more objectionable than those from composting material. Despite this, no complaints of odors have been recently recorded.[1] The composting operation is not expected to increase production of odors by a significant amount, given the present conditions; therefore, no appreciable impact from composting odors is expected.

Wind-blown particles of dust and litter are not expected to be a problem at either composting site. Despite the moderate windspeeds found at both sites, the dampness of the composting material and the enclosure surrounding the site would prevent materials from escaping and becoming a nuisance.

Another impact on air quality is due to vehicles involved in the project. At the Sierra Point site, these vehicles include trucks bringing refuse from the transfer station to the site, vehicles used in the composting process, and a tugboat used to transport the compost to the Delta. Pollutants emitted by trucks transporting the refuse will actually decrease due to the project. Refuse is currently taken from the San Francisco transfer station to a sanitary landfill area in Mountain View, approximately 35 miles to the south. The Demonstration project will divert about six truckloads per day to the composting site which is two miles from the transfer station. Vehicle emissions will be reduced by an approximate 400-mile decrease in vehicular mileage per day.

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[1] Personal communication with Jay Schmitzer, Air Pollution Inspector, Bay Area Air Pollution Control District, October 29, 1973.

Pollutants emitted by diesel-powered composting and yard vehicles and the tugboat will be insignificant, due to their small number and intermittent use.

In Berkeley, 46 truckloads a day will deliver raw refuse to the transfer station for processing and about 8 trucks will transfer refuse to the composting site. The change in amount of emissions is unknown since the transfer station site has not been selected, but it is expected to be negligible. As at Sierra Point, no significant effect on air quality is expected due to the composting vehicles and the tugboat.

Vehicles at the Mandeville Island site include a dump-truck, a scraper, a bulldozer, a water wagon and a crane. Emissions from these five vehicles will not be significant.

The loading and unloading operations at all three sites may cause blowing dust and litter. At the Berkeley and Sierra Point sites, flying debris can be minimized by use of a canvas chute for loading into the barge and by moistening the compost prior to loading. Another method might be to limit loading operations to the morning hours when windspeeds are generally lowest, or load only when windspeed is below a critical level which is to be determined by experience.

Windblown dust from the unloading operation and levee placement process at Mandeville Island could cause significant problems. Present plans call for unloading by a crane with a clamshell bucket into a dumptruck. This method has great potential for dust problems. Methods for combating this problem are similar to those used at the composting sites. The compost in the barge can be watered as it is unloaded, and restrictions can be set up regarding acceptable wind conditions for unloading. Another possible solution is the use of a covered conveyor to unload the compost from the barge.

Another possible problem is blowing dust due to wind erosion of the compost fill at Mandeville Island. The effect of wind erosion on air quality will be measured by the air quality monitoring program to determine the wind erodibility characteristics of compost relative to peat soil.

## D. NOISE

Noise at all three sites will be increased, mainly by vehicles involved in the project. The noise environment at Sierra Point and Berkeley sites will be affected by the trucks delivering the refuse, the equipment used in the composting process, and the equipment used in loading the barge. These sources are small and intermittent compared to the neighboring freeways and railroads already present. Both sites are relatively distant from noise-sensitive areas and are well isolated from the general public. For these reasons, no significant impact due to noise is expected at these sites.

New noise sources at Mandeville Island include a crane, dumptruck, scraper, bulldozer and water wagon. Due to the agricultural use of the surrounding land and long distances to residences, the increased noise level should not have a significant impact.

## E. LAND USE

The "Delta Master Recreation Plan"[1] offers a recreation and environmental policy plan for the Delta. It classifies Delta waterways by categories to denote the principal types of uses consistent with the waterways' capacity for accommodation of such uses. "They are intended as planning guides for the purposes of maintaining and furthering the trust purposes. Case-by-case analysis will still be required in determining allowable uses of these waterways in the long-term statewide public interest."[2] The istration's barge-unloading facility would not conform ie plan's "natural use channel" designation of the :ent waterway. This classification denotes areas )iting outstanding scenic, aesthetic and wildlife values ı should be preserved and does not permit new structures iprovements of any kind in or over the waterway. This was selected due to other overriding considerations rould have to receive special consideration in the .t approval process.

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[1] California State Resources Agency, Delta Master Recreation Plan, February 1973.

[2] California, Delta Master Recreation Plan, p. V-ii.

)emonstration's use of the Mandeville Island site would 'e the area landward of the levee from commercial agriıral production for a period of perhaps three to five :. The actual compost placement operation would require 'ears, with the remaining one to three years needed levelopment of the compost into a productive soil mantle.

the Berkeley and Sierra Point composting operations be temporary land use changes of the sites. They both revert to their undeveloped states at the com-.on of the project.

## 'ISUAL QUALITIES

### erkeley

ıajor visual impact of the composting site at the :ley landfill would be the barge-docking facility and :creened enclosure around the composting activities. :5-foot high structure would consist of a wire mesh .ng supported by cables with solid walls approximately :et high. The 12-foot wall would block direct views ıe composting operation, and the screening would tend )ntain any airborne matter within the structure. The :ion of landscaping as visual screens would be con-'ed and would enhance views of the structure. If care ıken with the barge-loading operation, it could be .dered a visually interesting waterfront activity.

:omposting structure and related vehicular activity be visible from the Berkeley hills to the east and ıotel complex to the south. The Demonstration could be viewed from Point Flemming and Golden Gate Fields ıe north. Views from Highway 80 would be minimal ıse of highway landscaping.

### 2. Sierra Point

The visual quality of the composting site at Sierra Point would be altered by the addition of a barge-loading dock and composting structure similar to that planned for Berkeley. The proposed site would no longer be vacant, and the addition of landscaping would enhance views of the structure. The composting structure and related vehicular activity would be visible from the industrial park and shipping channel to the south and portions of the Bayshore Freeway and Bayshore Boulevard to the west. The site would not be visible from any residences except for a few in the easternmost portion of South San Francisco across the freeway.

### 3. Mandeville Island

The Demonstration would alter visual experiences on a small portion of Mandeville Island. Additions to the agricultural landscape would include a crane mounted on a pier for barge-unloading operations, a short concrete pad on the levee, and an access ramp mounted on a trestle extending into the island. One small administrative office structure, possibly a trailer and a graveled parking area, would also be added.

The changing topography from the berm construction would not appreciably alter the visual quality of the site. Because Mandeville Island is an agricultural area, it is likely that the compost placement operation would not be visually obtrusive. The compost should appear similar to peat soils, and earth-moving activities would not be much different from normal agricultural operations. The barge-unloading operation, being nearly continuous over a two year period, would visually intrude on an otherwise natural waterway. However, barging operations for levee maintenance are common throughout Delta sloughs, and the barging for the Demonstration would not appear out of place.

## G. WATER QUALITY

Water quality is an important consideration in any large-scale solid waste disposal program and is also a critical factor when considering any alterations of the Delta.

While the Delta's water problems have been the subject of concern and study for several years, there is currently little information on the impact upon water quality from composted municipal refuse and sludge. It is therefore one of the primary functions of the Demonstration to gather information and evaluate any potential water quality hazards that might result from a large-scale project. Nevertheless the water pollution potential of the Demonstration itself must be considered.

Various stages of the Demonstration which could potentially impair water quality are:

1. Leachate from the compost operations at Berkeley and Sierra Point.
2. Barge-loading and unloading operations.
3. Leachate from the compost berm behind the levee.
4. Possible dredging operations at Sierra Point and Berkeley that might be necessary to accommodate barges.

The primary concerns are heavy metal toxicity, pathogen survival and possible long-term effects from trace substances in the plastics remaining in the compost.

### 1. Composting Operation

The benefit of composting refuse and sludge before land application is that it (1) stabilizes nitrogen that might otherwise get into streams or drinking water, (2) destroys pathogens and weed seeds and (3) eliminates odors.[1]

The material to be composted will consist of the light organic portion of municipal refuse (after shredding and air classification) and sewage sludge. Although metals, glass, heavy plastics and other materials would be removed from the refuse, some light plastics would remain.

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[1] J. Goldstein, "USDA Speaks Up for Municipal Composting," Rodale's Environment Action Bulletin, October 13, 1973, p. 5.

The refuse-sludge mixture provides a more optimum carbon: nitrogen ratio for composting, because refuse has a high C/N ratio (100:1) and sludge a low C/N ratio (around 10:1).[1] Municipal sewage sludge, however, can contain appreciable amounts of heavy metals. The amount is a function of the industrial input into the system and can vary considerably.[2]

During composting, a leachate will be produced, principally water and dissolved mineral salts. The amount of heavy metals in the leachate will depend upon the quantity in the original material, the pH of the compost and the stage of composting. The pH varies during the course of composting and heavy metals form an insoluble complex at pH levels above 7 but will leach out at pH below 7.[3]

The leachate from the Demonstration will be contained. The composting would occur on a paved surface, and the rain and drainage water will flow to a holding area. This drained water would be stored and recycled as needed to moisten the composting refuse. Questions involving compost which need further research in addition to the fate of heavy metals are the survival of viruses and long-term effects of composted refuse and sludge on soils, groundwater and crops.[4]

After composting, the material should reach a relatively stable state (the determination of stability or maturity of the compost is somewhat relative). Indicators of this include appearance and odor, final drop in temperature, self-heating capacity and amount of decomposable sistant organic matter.[1] The desired degree of ity is one in which the compost would not give rise nuisances when it is stored,[2] although it may contain appreciable amounts of heavy metals and resistant toxic materials. Materials such as PCBs not be affected by composting. Given the present ous materials disposal regulations, it is ly that much of this would reach the municipal ent system, except through occasional household al, and these concentrations would not be high. cs remaining in the compost also offer a potential erm hazard to fish and wildlife (see Fish and fe section).

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[1] R. Braun, "The Utilization of Refuse and Sewage Sludge by Means of Composting," Communication No. 166, Federal Institute for Water Supply, Federal Institute of Technology, Zurich, p. 13.

[2] Conversation with Dr. C. Golueke, research biologist, Sanitary Engineering Research Laboratory, University of California, Berkeley, November 6, 1973.

[3] Ibid.

[4] S. A. Hart, A Preliminary Compost Experiment and Suggestions for Compost Specifications, p. 24.

rge-Loading and Unloading

spillage of compost into the water is expected loading operations, although some spillage may during unloading.

to the "stabilized" condition of the material, no ce conditions are expected from limited amounts of ge. (This is assuming no gross amount of material reach the water.)

mpost Berm

jor water pollution potential of the Demonstration the Delta. It must be stressed, however, that refuse--sludge compost for agricultural purposes-- a unique idea.

fects of land application of compost have been ively studied in Europe and the U.S.[3] However,

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C. G. Golueke, Composting, p. 7.

Ibid., p. 42.

R. Braun, The Utilization of Refuse and Sewage by Means of Composting.

this study has been to examine the compost for its crop enhancement capabilities with some studies of crop uptake of heavy metals rather than for its water quality impacts. Most of the research is quite positive although points out that the potential long-term impacts of heavy metals buildup need further study.[1,2] A few researchers are more skeptical. One report indicated that "compost made from garbage contains poisonous heavy metals and chemical compounds, such as benzpyren and benzflourioles, which are found as cancer-causing agents."[3] Another noted that,

> Using sewage wastes in agriculture will not solve any disposal problems, but may give rise to new problems if the application is not based on detailed knowledge of the composition and properties of the wastes, together with knowledge of the biological and geochemical processes at work during decomposition. If cultivated fields are to be used for the disposal of sewage sludge or other wastes from urban areas, the rate of application should be based on the content of potentially hazardous components, whereby the plant nutrient and soil improvement aspects will be of secondary importance.[4]

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[1] J. C. Duggan, "Utilization of Municipal Refuse Compost," Compost Science, March-April 1973, pp. 24-25.

[2] D. A. Mays, G. L. Terman and J. C. Duggan, "Municipal Compost: Effects on Crop Yields and Soil Properties," Journal of Environmental Quality, January-March 1973, pp. 89-92.

[3] Wagner and Siddigi, article in Nature Science, Max Planck Institute Monthly, Geissen, West Germany.

[4] A. Anderson and K. O. Wilsson, "Enrichment of Trace Elements from Sewage Sludge Fertilizer in Soils and Plants," Ambio, October 1972.

hse problems relate directly to the water quality sect of the Demonstration because of the sensitive aure of the Delta environment. Rainwater, irrigation aer and natural seepage could leach pollutants from h compost into the island's drainage ditches. Drain-g from the ditches is pumped into Connection Slough ta point three-quarters of a mile from the Demonstration ie.

odefinitive answer regarding water quality impacts can egiven because of the lack of research on compost echate. The formation of the leachate is dependent pn the presence and movement of water through the opost. The quantity of leachate is dependent on the aer budget, applied water, run-off, infiltration, vpotranspiration, and changes in moisture retention ythe soil and compost. The quality of the leachate is eendent upon the type of materials leached.[1] The iution factor of the drainage water and Delta water old have a significant mitigating effect, but its anitude is unknown.

he foregoing comments on water quality are intended to dntify the potential environmental effects of a long-aje program involving a major portion of the solid ates of the region.

he Demonstration and its extensive monitoring activity old provide needed information without subjecting the eta itself to risk of serious impairment. The enstration is considered to be of small enough scale tcal coverage over the two-year period would be roughly 0 acres out of a total of 5,500 acres on Mandeville sland and 500,000 acres in the Delta) to test the esibility of the project and yet not cause significant eterioration of water quality in the Delta should derse effects be detected.

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[1] California Department of Water Resources, Sanitary alfill Studies, Bulletin No. 147-5, July 1969, p. 29.

The Central Valley Regional Water Quality Control Board has reviewed and provided input to the proposed monitoring program, although formal application for permit approval has not yet been made.

### 4. Dredging

A small amount of dredging may be needed at the barge-loading and unloading docks, but channels appear to be deep enough to accommodate loaded barges at high tide so that resulting water quality impacts should be negligible.

## H. SOCIOECONOMIC IMPACTS

At Mandeville Island approximately 15 to 20 jobs would be created for barge-unloading and compost placement operation and monitoring activities. Research, construction and operation contracts would be spread over a wide area, having little or no economic impact on any particular geographic location. In Berkeley, operation of the transfer station, the composting operation and barge loading would generate approximately 20-25 new jobs. Considering the size of the local labor force, the impact of these new jobs will be small. At Sierra Point, operation and maintenance of the composting station and the barge-loading facility would create employment for approximately 20 workers. Again, the economic impact of these new jobs is positive but small.

Careful siting of the Berkeley transfer station in the industrial area of the city should result in minimal adverse impacts on neighboring industrial or residential areas. Particular attention should be paid to the routing of collection vehicles through residential areas. The remote location of the composting sites at Berkeley and Sierra Point should result in no negative social impacts.

It is proposed that 10% of the total project cost of $6.8 million be shared by 11 counties of the Bay Area. It is expected that each county will be assessed its share of the total cost on the basis of population. The cost per year may range from $3,000 for smaller counties up to $45,000 for the larger counties. These projections are low enough not to have adverse impacts on the fiscal condition of any of these counties.

## I. UTILITIES

On Mandeville Island, the Demonstration would require electrical power to operate test equipment, lighting and small appliances at a trailer headquarters, but the amount would be insignificant. No alterations of the island's power system would be necessary.

Electricity for the Berkeley compost site would be used to operate electrical repair equipment, lights and small appliances. These amounts are not large enough to be significant, although a short extension of utility lines may be required.

It is estimated that the Berkeley transfer station annually would require 429,000 kilowatt hours (KWH) of electricity assuming a power requirement of 11 KWH/ton of refuse. A slightly larger power requirement may be needed, depending on the extent of resource recovery equipment installed. This need is not large enough to cause a significant impact on existing power distribution systems in the city. Water needs for the transfer station will be very small.

The composting operation will require larger amounts of water--perhaps 50,000 gallons per day, although rainfall and leachate recycling could substantially reduce this figure.

At Sierra Point there are no utility lines near the compost site, so new lines would have to be installed. Estimated cost for new water and electrical service connections is $60,000.

## J. HEALTH AND SAFETY

The following aspects of the Demonstration were evaluated for potential health and safety:

Pathogen survival
Flies breeding in composting area
Enhancement of rodent problems
Combustibility of compost
Gas production in compost berm (Mandeville Island)
Contamination of well-water

Several of these potential problems can be avoided by adherence to the recommendations for the operating specifications for composting.[1]

No health hazards from pathogens have been reported in connection with composting. The high temperatures (up to 60°C) reached within the compost pile and the antibiotic reaction of other organisms are responsible for destroying common pathogens.[2] This is dependent, of course, upon proper management of the composting process--i.e., proper turning of the windrows so that all sections are exposed to the high interior temperatures. The question of virus survival in composting has not been researched as yet.

Fly development is also a problem that can be avoided by proper management. The composting specifications indicate that a paved surface and frequent complete turning of the windrows should be adequate to eliminate any larvae production. However, chemical measures could be utilized if necessary. Once compost reaches a "stable" condition, it no longer contains the nutrient sources flies require and would not present any problems.

Although rats are a problem in waterfront areas, the panel surfaces of the yard enclosure and frequent turning of the compost would prevent any burrowing and establishment of rodents within the refuse-sludge material. Again, once this material is composted to a stable condition, as it would be before being barged to the Delta, it would no longer provide a suitable or nutritious habitat for pest rodents.

A combustibility test[3] on a sample of very dry compost showed it to be combustible. This indicates that compost,

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[1] S. A. Hart, A Preliminary Compost Experiment and Suggestions for Compost Specifications (see Volume III).

[2] C. G. Golueke, Composting, p. 67.

[3] A lighted cigarette was placed on top of the compost, and by fanning the cigarette the compost ignited and smoldered.

When wind-dried on the surface of the compost berm, would be subject to combustion, although probably no more so than the existing peat soils.

Gas production in the compost berm on the island would not occur with proper composting, because the compost would not undergo further decomposition except for possible surface oxidation.

Fresh-water (drinking) wells located near the Demonstration site on the island are cased to a depth of 100 to 130 feet and therefore would not be subject to contamination from leachates.

## K. SOLID WASTE OPERATIONS

The Demonstration would have a significant impact on solid waste operations in Berkeley since it would process all municipally collected wastes. Depending on the shredding equipment selected and the degree of screening, some residual material would require disposal in a landfill. This material is estimated to be a maximum of 20% of the incoming refuse, or 30 tons per day. This would reduce by 80% what Berkeley delivers to its landfill and would result in an overall reduction of 25% of refuse delivered to the landfill. Based on these projections, the project would extend the life of the present landfill from one year to three years.

The existing transfer station in San Francisco processes 2,000 tons per day of raw garbage; the Demonstration would divert 150 tons per day of this load. Considering the residual material requiring disposal from the composition operation, this would result in about a 6% reduction of material delivered to the Mountain View landfill site, a relatively negligible effect.

## L. TRANSPORTATION

### 1. Vehicles

Vehicular traffic on Mandeville Island would increase somewhat due to employees working at the test site, health and other inspectors, and visitors. About 2 1/2 miles of levee road from the bridge to the site would require graveling for winter use.

In Berkeley municipal route trucks would deliver refuse to the transfer station. Transfer trucks would then take composting material to the composting site five days per week. Because of the relatively heavy traffic usage at the transfer station, the city should locate the transfer station for easy access. The expected traffic volume into the station is 46 trips per day from city route trucks and, if needed, 17 trips per day from Oakland Scavenger trucks. Approximately eight transfer truck trips per day are expected from the transfer station to the composting site. Transfer trucks carry more volume than route trucks so that a slight net reduction in mileage may be realized between city streets and the composting site.

The existing major vehicular corridors along Gilman Street, University and Eastshore avenues should adequately service the transfer route to the landfill composting site. The proposed transportation route from the San Francisco transfer station to the compost site at Sierra Point, approximately two miles away, would be along a private dirt road adjacent to the Bayshore Freeway (Highway 101). Eight trips by 18-ton capacity, 40-foot self-dumping trucks would be required daily.

The proposed trucking from San Francisco to Sierra Point would reduce the total distance otherwise traveled to the Mountain View landfill by about 400 truck miles per day. In addition, trucks using the dirt road would not disturb public throughways or residential areas. The highway landscaping obscures these trucks from the view of motorists on the Bayshore Freeway.

### 2. Barging

One 600-ton barge per week would transport compost from each composting site to Mandeville Island. Figure 8 indicates the route up the San Joaquin River, across Frank's Tract, through deepwater channel and Middle River to the east side of Mandeville Island. Wave generation from barges is small due to their slow rate of travel so that wave erosion to Delta levees is expected to be minimal. The two barge trips per week should have no significant impact on the existing Delta waterway traffic.

The current barging operations in the adjacent Delta waterways indicate that no dredging should be needed except possibly some small amount at the unloading dock. Any dredging would cause a temporary but insignificant disturbance of the water.

The proposed barging in Berkeley would be from a site on the north face of the waterfront area bordering the landfill site. The water should be deep enough (6 feet at lower low tide) in this area for barging without dredging, although a small amount of dredging may be necessary for a "bathtub," or hole, at the dock. The 70-mile barge trip from Berkeley to the island would be made once a week.

A temporary breakwater would be required to protect the barging operation at the Berkeley site. The most effective and least expensive breakwater would be earthfill, which could be constructed from clean fill brought to the landfill site. It would extend 150 feet perpendicular to the land, rise 25 feet in height and be 20 feet in width at the apex. About 10,000 cubic yards of fill would be needed. Broken concrete would probably line the western exposure to reduce wave erosion.

Earthfill breakwaters are less desirable than wooden breakwaters on a long-term basis because they are more easily eroded and construction and removal would cause local turbidity.

The deep, calm and protected channel bordering the southern edge of Sierra Point should not require dredging for barging operations. The waters bordering the site are 10 feet at lower low tide, and Oyster Channel leads to the site at a lower low tide depth of 5 feet for 150 feet.[1]

Minor dredging adjacent to the wharf for the barge may also be required here. The barge would move once a week from Sierra Point to Mandeville Island, a distance of about 80 miles each way. The limited movement should have little adverse impact on existing channel traffic.

---

[1] U.S. Coast and Geodetic Survey Map No. 5527.

# VI. ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

dverse environmental effects of the Demonstration that annot be avoided include settlement and cracking along n 1,800-foot stretch of levee and possible leaching of ontaminants from the compost berm.

he extent to which each would occur cannot be deter-ined precisely and, as has been mentioned previously, he monitoring program during the Demonstration would rovide information on the degree of these effects.

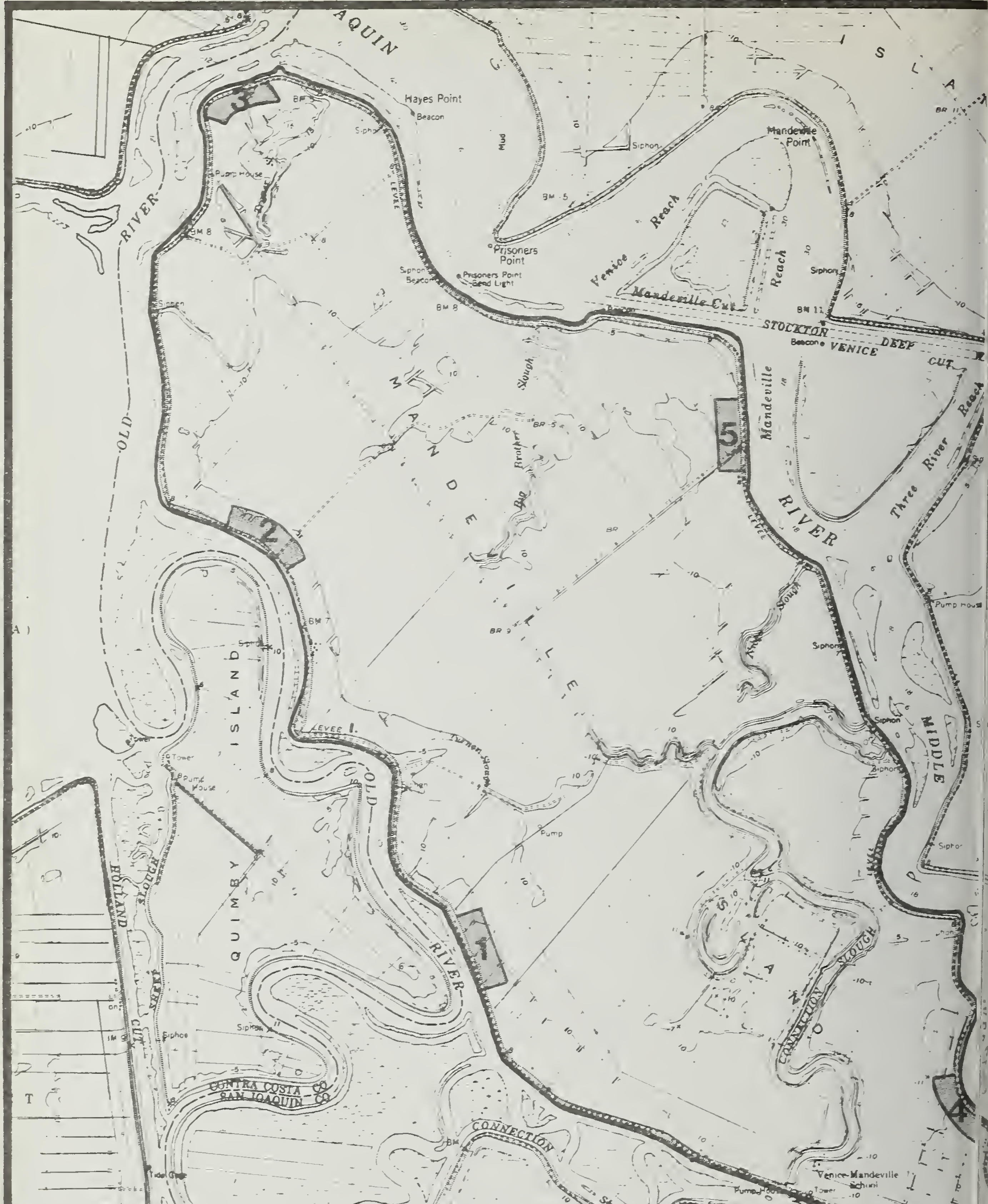
# VII. MITIGATION MEASURES PROPOSED TO MINIMIZE ENVIRONMENTAL EFFECTS OF THE PROJECT

The small scale of the Demonstration, its extensive monitoring program and several design features are mitigation measures incorporated in the project to minimize environmental effects.

The Demonstration would use less than 1% of the Bay Area's wastes and would only last for two years, during and after which the results would be carefully evaluated. Only 20 acres--of the 5,500 on Mandeville Island and 500,000 in the entire Delta--would be utilized.

Field observations of pore pressures, settlements and horizontal movements are included in the monitoring program to measure and assess the physical effects of the compost berm on the levee. Monitoring would be conducted on input refuse and sludge material, and on leachates from the composting operations and the compost berm to determine water quality and biotic effects. Air pollution and agricultural monitoring would also be conducted.

Mitigating design features of the project include air classification and screening of plastics and metals from the incoming refuse, a screened enclosure and capture of leachates at the composting yard, the drainage system under the berm to minimize water pressures, and slow construction of the berm using gradual slopes.



BOULDIN ISLAND QUADRANGLE
U.S.Geological Survey
1:24,000

# Alternative Island Sites

Figure 1

**Bay Delta Resource Recovery Demonstration Project**

eip / ABAG

# VIII. ALTERNATIVES

## A. NO PROJECT

If the project were not conducted, the feasibility of reinforcing Delta island levees with composted refuse and improving island soil quality could not be explored unless another similar project were proposed. Other methods would ultimately have to be developed to preserve the Delta islands, and Bay Area communities could not develop this option for disposal of organic solid wastes.

## B. ALTERNATE WASTE SOURCES

An important principle in the selection of source material was that refuse disposal is primarily a responsibility of government. As such, offers for source material were solicited from governmental units rather than privately franchised disposal operators, although the two often work closely together.

Other waste source candidates that were evaluated included Palo Alto, San Leandro, Oakland, San Joaquin County and a joint proposal from Antioch, Pittsburg, and Brentwood.

The key criteria used to evaluate the candidates were:

Sufficient quantity of refuse and sludge
Availability of a composting site
Endorsement by the governmental unit
Political and geographic regionality
Degree of community interest
Net cost to the Demonstration

The Pittsburg-Antioch-Brentwood area was not selected because of an insufficient refuse supply. The San

Joaquin County proposal came from the voluntary Countywide Solid Waste Management Committee and did not have the official endorsement of the County Board of Supervisors. The San Leandro, Oakland and Palo Alto alternatives did not fail to meet any specific criteria but did not offer proposals as strong as those from the cities finally selected.

## C. ALTERNATE ISLANDS

Other islands considered for the Demonstration site included Lower Jones Tract, Bradford Island, Orwood Tract, Woodward Island and Jersey Island. Islands were evaluated based on the following criteria:

Owner interest in levee reinforcement using compost
How typical the soil and levee conditions were of the Delta
Ease of accessibility by barge or rail
Lack of objections from neighboring landowners

On the basis of these criteria, Mandeville Island was judged to be the best overall site for the Demonstration project. First, the island is under single ownership, which simplifies the problem of objections from neighboring landowners. Second, the levee conditions were felt to be serious enough, yet not so severe as to cause unwarranted risks of conducting the Demonstration. Third, the island can be reached conveniently by barge. Finally, Al Zuckermann, the island owner, has a high interest in experimenting with levee reinforcement using compost.

## D. ALTERNATE SITES ON MANDEVILLE

The sites initially selected by Mr. Zuckermann as possible locations for the project are shown in Figure 12. Sites 1 and 2 were rejected because levee conditions were not as secure as at the other sites. Sites 3 and 5 were rejected primarily because of their distance from the Mandeville Island bridge--seven miles and five miles, respectively. Contractors will need to drive onto the island daily, and visitors are expected to frequent the site.

inimal driving distance on the levee roads is important o avoid interference with farming operations and because f severe mud problems that disrupt vehicular traffic uring winter rains. Site 5 is also in the middle of a heasant game preserve and would cause greater disruption o nesting fowl than Site 4, the site selected.

## . OTHER METHODS

t should be recognized that the Demonstration is a esearch project to test a possible future system for olid waste utilization. Regardless of the success r failure of the Demonstration as a whole, many of the rocesses developed would be useful conponents in an lternative system.

### . Landfills

he many small dumpsites in the Bay Area do not qualify s long-term alternatives to the solid waste disposal roblem because of their limited capacity and environental considerations. However, there are three major ong-term landfill proposals currently under considera-ion by local and county governments.

### . Potrero Hills Landfill

nvirosol, a Seattle-based land development company, has ade a preliminary proposal to use a 900-acre canyon in he Potrero Hills north of Suisun Marsh as a regional landill. The project does not propose to alter the jurisiction or contractual agreements that are currently in peration on the local level. Rather, it calls for an nspecified number of regional processing/transfer staions similar to the one in San Francisco. At each of hese stations, raw refuse would be compacted and then hipped via barge to dock facilities near the site. Trucks ould then haul the compacted refuse to the site. The volme of the dumpsite is estimated to be 114 million cubic ards and could theoretically serve as a landfill for the nine Bay Area counties and Sacramento and San Joaquin counties for 125 years.[1]

The Potrero Hills project is basically a disposal operation and does not directly address the questions of resource recovery from solid wastes or regional management of solid wastes. The project is currently being reviewed by the Solano County Planning Commission.

b. Ox Mountain Landfill

This 2,100-acre site, proposed by San Mateo County Scavenger Company, is located north of State Highway 92 and west of Skyline Boulevard in San Mateo County. The site consists of two steep narrow canyons, one of which has been partially prepared for use as a dumpsite. The proposed fill would cover approximately 200 acres of the site to a depth of several hundred feet and is estimated to have sufficient capacity to serve the needs of San Mateo County until the year 2000.

So far, this site is intended to serve only residences and industries in San Mateo County. This is a conventional sanitary landfill, and resource recovery is not anticipated.

Implementation of this proposal would require the improvement of State Highway 92 to freeway status. The State Division of Highways has postponed this project to 1981 at the earliest, and considerable opposition to improvement has already been expressed by local residents.

c. Kaiser-Radum Land Reclamation Project

This project is proposed by Kaiser Sand & Gravel Corporation to reclaim a 775-acre quarry site near the city of Pleasanton (within Alameda County jurisdiction) regional sanitary landfill. Over a four-year period, cre modules would be filled with solid waste and later d be covered with excess overburden. The site would be available for alternate land use.

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[1] Solano County Planning Commission, Draft Potrero Hills Environmental Impact Report, July 5, 1973, prepared by Wilsey & Ham with Cooper Clark & Associates, Wildlife Associates, and William C. Ellis, Groundwater Geologist.

ous questions with regard to possible contamination ocal groundwater reserves have been raised by local ps and the State Water Quality Control Board. On ber 4, 1973, the State Board reviewed the project ruled that the site could only be filled to a depth 0 feet, thus reducing the capacity of the site by than 50%. No decision has been announced by Kaiser cials as to their next move.

### Rail Transport to Areas Outside the Bay Area[1]

969 Western Pacific Railroad made a proposal to the of San Francisco to haul their municipal waste by n to Lassen County in Northern California. The prod system called for a special unit train for transing the refuse to rural parts of Lassen County and ibly to Nevada. Both areas have an almost unlimited city to accept wastes for landfill. However, this osal was abandoned because of its high cost and tical considerations. Unless a new proposal is ncoming which includes resource recovery and a reclaon program, it appears unlikely that this proposal d be a viable disposal practice.

## Energy Production

### Incineration

ization of municipal solid waste as a source of gy for generating electricity is widely used in pe but is only in limited use in the United States. ne Bay Area, all PG&E plants are run on natural gas il and are unable to use municipal waste as fuel. ver, several local firms have developed systems for gy production based on incineration.

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[1] Commonwealth Club of San Francisco, What Method of d Waste Disposal Should be Used in San Francisco? Two, Volume LXIII, No. 51, December 22, 1969.

Combustion Power Corporation of Menlo Park has been developing a gas turbine power generation system fueled with processed municipal solid waste. This method is compact, offers flexibility of location, and can recover metal and glass from the solid waste stream.

The CPC system could be complementary to the system proposed in the Demonstration since rubber and plastic are not compostable but do have very high heat content. However, the CPC system is still in the development stage and its limited daily capacity of 150 tons per unit may preclude its use as a general solution to waste disposal problems in a large metropolitan region.

The Sira Corporation of Los Gatos has developed a system for processing refuse to separate glass and metals from the combustible fraction which is used as fuel in conventional power plants. The combustibles are subjected to heat and pressure to produce either pellets or "dense logs" which have a heat content of about 7,000 BTUs per pound. The system is in the development stage and is being actively marketed by the firm.

### b. Pyrolysis

Destructive distillation, called pyrolysis, was adapted from its use in manufacturing coke and charcoal to its current application for reduction of municipal solid wastes. Several commercial systems have been designed by such companies as Monsanto, Garrett and Union Carbide, and the process has been thoroughly studied by the U.S. Bureau of Mines. Similar to the incineration process, pyrolysis operates at high temperatures and can produce fuel gas and oil or be utilized to generate steam. No fully operational systems have yet been installed in this country.

# IX. RELATIONSHIP BETWEEN SHORT-TERM USE AND LONG-TERM ENHANCEMENT OF THE ENVIRONMENT

The concept of the Demonstration is the short-term use of the 20-acre site on Mandeville Island to demonstrate on a small scale the feasibility of compost placement as a levee reinforcement and soil-building material. Even on a small scale, the Demonstration involves some site impairment and risks. The Demonstration would remove the 20-acre site from agricultural production for a minimum period of two years, although agricultural productivity experiments may be conducted during this time. The time required for the compost berm surface to stabilize, mature and become agriculturally productive is not known and would be one of the many questions answered by the Demonstration.

The long-term opportunity of the Demonstration, if successful, would be to provide the basis for regional application of this method of protecting Delta islands. The primary benefit of widespread application of this system would be the preservation of valuable agricultural lands by reinforcing levees to prevent island inundation and by eventually raising the level of the island interior with compost, reversing or at least halting current land subsidence problems due to bio-oxidation. Another benefit would be the enhancement of Delta water quality by reducing the probability of levee breaks. Severe levee breaks result in saline intrusion that is damaging to freshwater fisheries, agricultural production and important domestic water supplies of the Delta. Secondary long-range benefits would include the enhancement of recreational wildlife use of the Delta.

On a regional basis, the environment would be enhanced by the reuse rather than disposal of municipal solid waste components. Valuable resources such as metals and organic materials would not be lost but would be reintroduced to the natural resource stream. This would reduce degradation of the environment while preserving invaluable agricultural lands and natural resources.

Risks involved in the Demonstration include possible air quality degradation due to increased particulate generation, water quality degradation due to leachate from the compost that could also seriously damage fisheries in the immediate area, settlement and cracking of the levee and, in the extreme, a possible break in the levee and inundation of the island.

# X. IRREVERSIBLE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

The only irreversible environmental effect of the project would be the placement of a berm behind 1,800 feet of levee on 20 acres of Mandeville Island. Composting operations at both Sierra Point and the Berkeley landfill are intended to be temporary; therefore, the commitment of land to these operations would not be irreversible, and they could revert to their previous state at the end of the Demonstration.

## XI. GROWTH-INDUCING IMPACTS

The temporary growth-inducing impacts of the Demonstra would be limited to a small increase in local employme on Mandeville Island and in Berkeley and South San Francisco.

If the Demonstration proves successful and a full regi system is initiated, there would be three potential gr inducing impacts. They are:

1. Stabilization of the levees that currently protect Delta islands could provide the necessary assuranc of safety that would increase the likelihood of no-agricultural development of the area. This type c development has already occurred in eastern Contra Costa County. The likelihood of commercial or recreational development would require careful lar use planning to guarantee the preservation of thos qualities of the Delta felt to be most valuable.

2. Full-scale regional resource recovery operations would allow for expansion of the secondary materia market. Currently, inconsistent supplies have hampered expansion of processing facilities due to high capital investment costs. However, a regiona resource recovery operation would provide a consistent supply and would make capital outlay for facilities and equipment economically justifiable.

3. An effective system of mechanical resource recover and environmentally sound disposal could tend to reduce the public's concern about decreasing the quantity of solid waste generation.

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# SOLID WASTE MANAGEMENT IMPLEMENTATION PROJECT

## SAN FRANCISCO BAY AREA

### Volume III

### Technical Report on Levee Stabilization and Composting

ABAG ASSOCIATION OF BAY AREA GOVERNMENTS

# AREA
# D WASTE MANAGEMENT
# EMENTATION PROJECT

## VOLUME III

## TECHNICAL REPORT ON LEVEE STABILIZATION AND COMPOSTING

A Report Prepared for the Action Committee for
the Bay Delta Resource Recovery Demonstration
and the Association of Bay Area Governments

December 1973 by

ENVIRONMENTAL IMPACT
PLANNING CORPORATION
SAN FRANCISCO, CALIF.

eip

In association with Frank Stead

ABAG ASSOCIATION
OF BAY AREA
GOVERNMENTS

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This document is Volume III of a three-part report to ABAG. This report documents the planning conducted for the Bay Delta Resource Recovery Demonstration project. This proposed project would demonstrate recovery of resources from urban wastes and the use of composted refuse for island reclamation in the Sacramento-San Joaquin Delta. The report presents original research on the use of compost as a levee strengthening material and documents the planning for an intergovernmental structure to manage the demonstration, and serve as a first step towards eventual regional management of solid wastes. The report is published in three volumes, as follows:

Vol. I: Project Report
Vol. II: Environmental Evaluation for the Bay Delta Resource Recovery Demonstration Project
Vol. III: Technical Report on Levee Stabilization and Composting

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December 14, 1973

Mr. Revan A. F. Tranter
Executive Director
Association of Bay Area Governments
Claremont Hotel
Berkeley, California 94705

Dear Mr. Tranter:

In the fall of 1972 a group of local agencies in the San Francisco Bay Area joined together in an attempt to initiate a Demonstration project to test the feasibility of using composted organic solid wastes in the low-lying islands of the Sacramento-San Joaquin Delta for levee stabilization, land building and agricultural purposes. These local agencies, calling themselves the Bay Delta Resource Recovery Action Committee, also sought to develop the intergovernmental institution necessary to manage this Demonstration project and perhaps to become the regional agency charged with solid waste management. This report documents the efforts of these local entities, acting voluntarily, to attempt to improve the technical and governmental mechanisms operating in the field of solid waste management today.

The report is presented in three volumes. Volume 1 describes the preliminary system design for the Demonstration project and looks at the concept of Bay-area wide implementation of the plan. It also details the possible institutional mechanisms necessary to implement the plan. Volume 2 is an environmental evaluation of the Demonstration project and is written in the format of an Environmental Impact Report. Volume 3 contains two technical reports upon which the preliminary system design was based. Part A is a study of the structural characteristics of compost and an evaluation of the feasibility of using compost as a levee strengthening material. This report, prepared by Drs. Duncan and Seed of the Engineering Department of the University of California, Berkeley, represents original research on this subject. Part B documents the preliminary compost experiment conducted by Dr. Samuel Hart at Davis, California, and includes recommended composting specifications for the Demonstration.

The consultants wish to thank the members of the Action Committee and its chairman, Councilman Fred Maggiora, for making this report possible. We would also like to thank the U.S. Army Corps of Engineers (San Francisco and Sacramento Districts), the

California Department of Water Resources, the Central Valley Regional Water Quality Control Board, and the California Water Resources Control Board for their valuable contributions. Further, we would like to thank the Sierra Club, the League of Women Voters and the San Francisco Planning and Urban Renewal Association, as well as the many public and private organizations and individuals who participated in this study.

Yours very truly,

Hans A. and Frank M Stead

Hans A. Feibusch, P.E.
Frank M. Stead

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ART B

"A Preliminary Compost Experiment and Suggestions for Compost Specifications" by S. A. Hart, C.E.

# PART A

# A STUDY OF THE FEASIBILITY OF STABILIZING DELTA LEVEES WITH A BERM OF COMPOSTED MUNICIPAL WASTE

by

J. M. Duncan and H. Bolton Seed
with an appendix by Celso Ugas

## irpose of Report

is report presents the results of our study of the feasibility of abilizing delta levees with a berm of composted municipal waste or a xture of composted municipal waste and dredger spoils. Our study has en concerned with evaluating (1) the mechanism of stabilization and fectiveness of a compost berm, (2) the effects of a compost berm on the epage, settlement, and stability of the levee and the land adjacent to e levee, and (3) the construction problems which can be anticipated on e basis of previously reported experience in filling over the peat lands the California Delta.

e study included a program of laboratory tests to determine the density, mpressibility, permeability and shear strength of the compost material. formation on the soil conditions in the Delta was obtained from published pers and reports, from discussions with the personnel of the California partment of Water Resources and the U. S. Army Corps of Engineers, and om discussions with other people knowledgeable and experienced in Delta il and levee problems.

e study is concerned with the feasibility of the stabilization program general, rather than its application to a particular site. It is lieved that the conclusions and recommendations will be applicable to st sites in the Delta. If a particular site is selected for further udy, however, test borings will be required to evaluate the soil conditions the site. In addition, a program of field observations should be undertken during any field test to make a closer evaluation of settlements, epage conditions, and safety.

## esent Conditions of the Levees

ere are 1100 miles of levees in the Delta. The manner of their conruction and present conditions vary widely. A cross-section through a vee depicting conditions typical of many sites in the central Delta is own in Fig. 1. As indicated in this figure, the crests of most sections the levees are about 10 ft. above sea level. The highest water level pected in 100 years is about 7.5 ft. above sea level throughout most of the central Delta. The island floor elevations vary from island to island and from place to place on each island. At most locations in the central Delta the elevations of the island floor vary from sea level to 20 ft. below sea level. The widths of the levees and the steepness of the levee slopes also vary considerably from place to place.

Many sections of the levees have been constructed of several different types of fill. These include sands, silts, clays, and peat. When these soils were placed on the peat subsoil, the peat compressed, and a large portion of the fill settled into the peat. At many locations the levee has settled so much that less than half of the fill now protrudes above the original level of the top of the peat.

The thickness of the peat subsoil varies throughout the Delta, reaching a maximum in excess of 50 ft. in a few small areas. In a large area of the central Delta its thickness is 30 ft. or more. Beneath the peat there is usually a thin layer of peaty silt or clay, and beneath that a layer of sand. The grain size of the sand varies from fine to coarse, and in places there are even zones of gravel. The water in the sand is normally under artesian pressure, and would rise in a standpipe above the level of the island floor. The water level in the peat is maintained at or below ground level by networks of irrigation and drainage ditches. Because the head of the water in the sand is higher than in the peat, water seeps upward steadily through the peat and must be pumped over the levees to keep the water level below the island floor. Water also seeps through the levees, especially in sections where they are built of sand.

## Problems of Levee Performance

A. Seeping Water Erodes Soils and Weakens Levees. A widespread problem in the Delta is the erosion caused by water seeping through and under the levees. Where the seepage is concentrated in zones of permeable soils or cracks, the flow velocities may be sufficient to dislodge and erode soil particles, as shown in the upper part of Fig. 2. If erosion is allowed to continue, the condition will grow steadily worse. An advanced stage of erosion, with an eroded "pipe" having formed under the levee, is shown in the lower part of Fig. 2. Such a pipe will continue to work its way backward under the levee util the weight of the overlying soil is great enough to cause the pipe t collapse. Then a portion of the levee slope may collapse into the ppe, forming a sinkhole. Collapse is most likely to occur where the lvee slope is already cracked, as are the landside slopes in some lcations. These cracks are probably the result of differential settlemnt of the levee. We believe that this is the mechanism by which sinkhles form in the landsides of levees during high water periods. The cacks and the erosion greatly weaken the levee, essentially removing the spport of the landside of the levee in the area of erosion.

B Weakened Sections Can Fail During High Water. A rise in the water lvel has two dangerous effects on this weakened section of the levee. Frst, the water pressures in the remaining stable portion of the levee icrease. The increased water pressure on the base of this section tends, i effect, to float it up out of position. At the same time, during high wter, the horizontal thrust of the water increases. Eventually, when the wter is high enough and exerts enough force on the levee, the weakened stion may be shoved inward, as shown in Fig. 3, causing a breach in the lvee and flooding of the island. These mechanisms of failure appear to b consistent with accounts of the events leading up to levee failures a the movements observed during failures, and it is believed that these mhanisms were probably operative in many of the more than 50 levee flures which have occurred since 1900.

C Gradual Settlement Requires Continued Building to Maintain the Grade of t Levees. The spongy peat soils beneath the levees not only settle a lage amount during the time when fill is being placed on them, but they alo continue to settle over a long period of time thereafter. Consequently, t levees built on peat are settling continually at rates up to 6 inches pe year. This settlement must be compensated for by regularly placing more fil on the levees to keep their crests high enough to afford the required ptection against flooding.

Th magnitudes of the settlements of fills on peat are shown in Fig. 3. Ths chart was developed using data compiled by the California Department of Water Resources and the U. S. Army Corps of Engineers. The chart relates the settlements due to compression of a 30 ft. thick layer of peat to the increase in effective stress due to the weight of the fill. The increase in effective stress is equal to the thickness of the fill multiplied by the moist density of the fill material if the fill is above water. If the fill is below water, the increase in effective stress is equal to the fill thickness multiplied by the buoyant density of the fill.

As an example, consider 5 ft. of sand fill placed on a 30 ft. thick peat layer. As shown in the table at the top of Fig. 4, if the fill were above water, the increase in effective stress would be 550 psf, and the settlement would be about 9.3 ft. In fact, if the fill settled 9.3 ft. it would be entirely below water, because the water table is very near ground level in the peat. Assuming that the entire 5 ft. of fill was under water, the increase in effective stress would be 250 psf and the settlement would be about 4.4 ft. Depending on the exact position of the water table, nearly the entire 5 ft. of sand fill would sink into the peat.

If a lighter fill material was placed on the peat, the increase in effective stress and the resulting settlement would be smaller. A 5 ft. layer of compost placed on a 30 ft. thick layer of peat would settle about 2.8 ft.

The settlements due to compression of peat layers are approximately proportional to the thickness of the layer. Fig. 4 may be used to calculate settlements due to compression of peat layers of other thicknesses by correcting the settlement in proportion to the thickness of the layer.

D. Subsidence of Island Floors is Gradually Increasing the Levee Heights and Water Head Differentials. Perhaps the most significant Delta problem in the long run will prove to be the fact that the island floors are gradually subsiding. Data are shown in Fig. 5 for three Delta islands, which indicate average subsidence rates of about 2.5 inches to 3 inches per year over a period of more than 40 years (Weir, 1971). The greatest part of this subsidence (about 80%) is believed to be due to oxidation of the organic peat soils where they are permitted to become dry at the ground surface (Winslow, 1973). The remainder is attributed to burning of the peat, settlement due to compression of the peat, and deep-seated settlement.

subsidence occurs, the island floors drop farther and farther
he crests of the levees, increasing the effective heights of the
The water head differential across the levees thus also in-
, and the levees are subjected to continually increasing water
This increases the likelihood of failure in weak sections of the
The water load increases in proportion to the square of the head
tial across the levee, and a levee with a 20 ft. differential
hstand a load four times as great as a levee with a 10 ft.
tial.

Peat Soils Make Construction Difficult. The Delta peat soils
only very compressible, they are also very weak. Heavily loaded
nd other equipment can break through the stronger crust at the
and bog down in the peat. Rapid filling on the peat can result in
material breaking through the surface of the peat if the fill is
o high or the slopes are too steep. To build high fills on the
is necessary to increase the thickness of the fill gradually,
the peat to compress and gain strength under the added load.

### es of Compost and Mixture of Sand and Compost

ndix to this report contains the results of a program of
ory tests performed by Mr. Celso Ugas, a graduate student at the
ity of California, to determine the properties of the compost and
re of equal parts (by weight) of compost and sand.

ost tested was prepared by Dr. Samuel A. Hart,* and is considered
presentative of the type of material which will be produced by the
ale composting of municipal wastes. The material is dark brown when
has the appearance of leaf mulch. The largest particles in the
received were about 3/8 inch and the finest were fine sand size.
cific gravity of the solid particles is very low, probably close to
The sand mixed with the compost for some of the tests was a fine,
river sand dredged from the Sacramento River.

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sults of tests on an older compost are described in Appendix B.

A. Compaction Characteristics and Densities. Particulate materials such as soils and compost do not have a single characteristic density. Depending on the amount of effort expended in compacting them, and the amount of water they contain when compacted, they can have a wide range of densities.

To determine what densities the compost and the mixture of compost and sand might be compacted to in the field, these materials were subjected to the Standard AASHO compaction test in the laboratory. This test was devised to simulate the best compaction achievable with light rollers in the field. Experience with clay soils indicates that compaction with a small bulldozer produces lighter pressures and lower densities, on the order of 85% to 90% of the values achievable in the Standard AASHO test. It is assumed that the same would be true for the compost or the mixture of sand and compost.

The results of the compaction tests are shown in Fig. 6. In this figure the dry densities of the materials have been plotted against the water contents during compaction. The dry unit weight is the weight of solids divided by the volume of the sample, and is thus a measure of the amount of solid material per unit volume. It can be seen that the densities of both materials first increase and then decrease with increasing water content. The maximum dry densities are 39 $lb/ft^3$ for the compost and 57 $lb/ft^3$ for the mixture of compost and sand. The optimum water contents (the water contents which produce the maximum densities) are 75% for the compost and 50% for the mixture. These water contents are expressed in percent of the dry weights.

If the compost were compacted in the field to 85% of its maximum density in the Standard AASHO tests, its dry density would be 33 $lb/ft^3$. Even if the material were compacted at the optimum water content its voids would not be filled with water, and the water content of the material could increase as it absorbed additional water from rainfall or irrigation. If the water content reached 100%, which seems possible, the moist density of the material would be 66 $lb/ft^3$. We have assumed in our studies that the moist density of the compost in the field will be 65 $lb/ft^3$. This value should be checked by field measurements if a test section of berm is built.

he mixture of compost and sand was compacted to 85% of the maximum, dry density would be 48 lb/ft$^3$. If its water content subsequently ceased to 75%, the moist unit weight would be 85 lb/ft$^3$, or 19 lb/ft$^3$ eter than the anticipated moist density of the compost without sand. cuse settlements are smaller and stability problems less if the fill is gter, it would thus be advantageous from the point of view of density se the compost by itself with no sand added.

Compressibility. If the compacted compost is subjected to pressure it compress. The lower part of the fill in the berm, for example, will ress under the weight of the overlying material. The amount of compres- depends on the density and the applied pressure. The results in Fig. 7 that at the base of a 16 ft. deep fill with a moist density of 65 lb/ft$^3$, compost would compress about 14%. The average compression for the thickness of the fill would be less, about 9%. Although these amounts ompression are quite large compared to the compression of most soils, are not very large compared to the compression of the peat. Because settlements will occur due to compression of the peat, the settle- s due to compression of the compost do not appear to be a cause for concern.

e same percentage of maximum dry density, the mixture of compost and compressed somewhat less than the compost without sand, but the rence was not very large. Based on considerations of compressibility, would be little benefit from mixing sand with the compost.

ermeability. The results of falling-head permeability tests on the st and the compost-sand mixture are shown in Fig. 8. The permeabilities th materials vary considerably with density. In addition, the perme- ty of the compost appears to be affected appreciably by the compaction content. All specimens were saturated when tested, and it appears the effect of the water content must be due to some difference in the gement of the compost particles. Why there is not a similar effect in ase of the compost-sand mixture is not clear.

desirable that the permeability of the fill in the stabilizing berm d be as high as possible. The results in Fig. 8 indicate that adding sand to the compost does not increase its permeability greatly, and consequently there is no great advantage from the standpoint of permeability, from mixing sand with the compost for construction purposes.

The permeability values shown in Fig. 8 range from 5 x $10^{-5}$ cm/sec to $10^{-2}$ cm/sec. These values are comparable to the permeabilities of fine sands and silty sands ($10^{-1}$ cm/sec to $10^{-5}$ cm/sec) and are generally greater than the permeability of peat (5 x $10^{-5}$ cm/sec to $10^{-7}$ cm/sec depending on how much the peat has been compressed). The values shown in Fig. 8 are values of vertical permeability. Owing to the fact that the compost contains many sheet-shaped pieces which tend to assume horizontal orientations during compaction, it is believed that the horizontal permeability would be higher, though how much higher is not known. In-situ tests to measure the permeability of the compost should be performed during any field test program.

D. Shear Strength. Drained direct shear tests were performed to determine the shear strength characteristics of the compost and the mixture of compost and sand. The results of some of these tests are shown in Fig. 9. The strength of both materials increased with increasing normal stress and density. Both materials exhibited friction angles comparable to those of sands at medium densities and appreciable amounts of cohesion, apparently from overlapping and interlocking of particles. It should be remembered, however, that these materials are quite compressible, and quite large movements would be required to mobilize their full strengths.

Only the drained strengths of the materials were measured because their permeabilities are high enough to conclude that they will be able to drain freely during construction. Furthermore, in their partly saturated condition after filling, the drained and undrained strengths should be the same for all practical purposes.

Because the compost and the mixture of compost and sand have very similar strength and compressibility characteristics, and because both appear to have fully adequate strength for use in a stabilizing berm, there is no advantage with regard to strength to be achieved by mixing sand with the compost.

Filter Performance. In order to determine if the compost material was ble of acting as a filter for silts and sands, a test was performed hich an attempt was made to wash a silty material through a thin layer ompost. No silt was washed through the compost, indicating that the ost can serve as a filter for fine-grained soils.

Conclusion Regarding the Benefits of Mixing Sand with the Compost. tests performed showed that mixing sand with the compost increases its ity but has little effect on its compressibility, permeability and ngth. Because increased density is not desirable, it is concluded that ill be better not to mix sand with the compost if it is to be used for truction of a berm behind the levees.

## s of Constructing a Compost Berm

berm considered in this report would be built with a uniform slope of orizontal to 1 vertical from the crest of the levee to the island floor. a levee 20 ft. high, the berm would extend 500 ft. inland from the e crest.

Stabilization Against Erosion. One of the most effective methods of ecting erosion of soil by seeping water is to provide a "weighted drain" at the point where the water discharges from the ground. filter drain allows the water to pass freely, but prevents the soil oving. If the compost were more permeable than all of the soils n it, it would perform as a weighted filter drain by itself, with no or additional drains. The test data indicate that the compost is ally more permeable than the peat, but it may be less permeable than sandy soils in the levees. Therefore it will be necessary to provide ainage system beneath the berm to be sure that no appreciable water es can build up beneath the berm where seepage emerges from the ills.

means for providing good drainage is shown in Fig. 10. The drainage consists of a number of ditches containing perforated drain pipes ounded by gravel and filter material. The pipe should be capable of ying a flow of 0.1 ft$^3$ per minute with a hydraulic gradient (or slope of the hydraulic grade line) equal to 0.007. The pipe should be surrounded with clean fine gravel, and the gravel should be surrounded by a clean sand which satisfies normal filter requirements with respect to the soil in which the drain is constructed, so that the soil will not be washed into the drain and plug it. The ditches should be a minimum 4 ft. deep and 1.5 ft. wide. One ditch runs parallel to the levee, as close to the toe as it can be conveniently constructed, and not more than about 20 ft. from the toe. This ditch connects to the other ditches, spaced at intervals of 100 ft., running in the perpendicular direction. Beyond the point where the ditches emerge from beneath the compost berm, they are open, connecting eventually with the existing ditches on the island.

Additional drains should be installed where it is known that seepage emerges from the levee slope when the river level is high. In these places, drains should be built extending from the toe drain up the slope to the area where the water emerges. Additional drains should also be built where there are springs or wet spots in the peat within the area to be covered by the berm. Drains should be built leading from the wet spot to the closest drain.

Any other drainage system providing equal drainage capacity and pressure relief could also be used. A two-foot thick uniform blanket of sand with a permeability of at least $10^{-2}$ cm/sec would provide the required drainage. It would have the advantage of not requiring disruption of the surface of the peat, but would have the disadvantage that its greater weight would cause more settlement. We believe that the capacity of these drains will be sufficient to carry away the water seeping horizontally through the levee and vertically upward through the peat without permitting dangerous pressures to build up beneath the berm. An adequate system of drains will provide improved safety against erosion and weakening of the levees. We consider provision of features for drainage and erosion control to be essential, because increased water pressures would endanger the stability of the levee, and because erosion beneath the berm would be difficult or impossible to detect and might progress to the point of catastrophic failure without any externally detectable signs.

B. Stabilization Against Catastrophic Levee Failure. Providing adequate filter drains to prevent erosion will also prevent the associated weakening of the levees. In addition, the berm would provide weight and strength to buttress the levee against the high water forces. In order to provide sufficiently high strength and low compressibility to perform effectively as a buttress, the compost should be compacted to a reasonably good density, on the order of 90% of the maximum dry density in the Standard AASHO Compaction Test.

Eventually, after the berm has been constructed, it will be possible to increase the height of the levee with less risk of failure than is now possible. The higher levee will provide increased safety against overtopping and additional weight to resist uplift at high water level. The berm will not affect the stability of the levee with respect to failure of the water-side slope.

C. Settlement, Cracking, and Loss of Freeboard. Placing the berm behind the levee will cause settlement due to compression of the underlying peat. This settlement will be greatest in the region of the toe of the levee, where the height of the berm is greatest. The weight of the berm will also cause some settlement of the levee itself.

The amount of settlement which would result from construction of a compost berm has been calculated for the conditions shown in Fig. 1, using the settlement data shown in Fig. 4. The results of the calculations are presented in Fig. 11. The calculated settlements increase from 0.8 ft. at the levee centerline to a maximum of about 8 ft. at the levee toe, and then decreased to zero at the toe of the berm. These calculations are based on an assumed peat thickness of 30 ft. and a berm 16 ft. high at the toe of the levee. The settlements would be smaller if the peat thickness was less than 30 ft. or if the berm thickness were less than 16 ft. Conversely, if the peat were thicker or the berm higher, the settlements would be proportionately greater.

The settlements indicated in Fig. 4 and Fig. 11 are long-term settlements. Experience with fills on peats in the Delta indicates that about half of the settlement will have taken place by the time the fill has been placed, provided that filling takes 3 months or more. The remaining settlement will take place over a period of years, with about 70% of the total occurring after 3 years, and 90% after 30 years. Settlements would continue even after 30 years, but at a greatly reduced rate.

These nonuniform settlements will cause the levee to crack, as shown in Fig. 12. With the water side of the levee settling less than a foot and the landside toe of the levee settling 8 ft., the levee will be split open at the top. The result might be a single crack as shown in Fig. 12, or a series of cracks. They may be located at the crest of the levee or on the inside slope. They would be expected to be generally parallel to the longitudinal axis of the levee, but they could conceivably cross the axis at a small angle, depending on the locations of the weakest soils in the levee.

This is the most dangerous consequence of building the berm. The cracks, if left unrepaired, could endanger the levee in a number of ways. First, if the cracks crossed the levee diagonally, they could form paths for serious leakage through the levees and flows of high enough velocity to cause dangerous erosion. Second, the levee fill would eventually collapse into the open cracks, resulting in extensive deterioration and weakening of the levees. In addition, wide cracks would disrupt the levee roads and make driving on them dangerous or impossible.

There does not appear to be any feasible way of preventing the nonuniform settlement or the associated cracking. A procedure for repairing the cracks might be developed, but there are some serious difficulties which must be faced: If the cracks were filled with soil it would be difficult to insure that the bottom of the crack was filled, and it would not be possible to compact the soil except near the surface. Any method of repair would have to be repeated, because the settlement will continue over a long time, and the cracks can be expected to reopen as the settlement continues. Cracks developing on the levee slope after the berm is complete would not be visible, because the slope will be covered by the berm. Unless the cracks extend up through the compost berm, they will not be seen.

Th drain at the toe of the levee will settle as the ground surface se tles in that location and will eventually be eight feet below its or ginal elevation. The perpendicular drains will also settle and will ev ntually slope upward from the levee toe drain to the edge of the compost be m. Under this condition the drains will be filled with water under pr ssure all the time. The head levels in the drains should remain unch nged, however, and they should function as well after having settled as they did before.

To maintain the present freeboard, it would be necessary to build up the le ee to compensate for the settlement. The berm would increase the stabi ity of the levee with respect to failures due to the water load and fa lures toward the inside. The berm would not affect the stability of th water-side slope, but increasing the height would tend to make this sl pe less stable. To minimize this, it would be desirable to increase th height of the levee by placing the added fill so that the water-side sl pe is not made steeper as the crest is raised.

## Su mary of Effects of Using a Compost Berm

Th benefits to be derived from building a compost berm behind the levees ar : (1) The berm will provide increased stability on the land-side slope of the levee, and (2) To construct the berm it is essential first to in tall a system of filter drains. These drains will provide a good measure of control over erosion.

Th detrimental effects of a berm are: (1) It will cause non-uniform se tlement of the levee which will result in cracking. These cracks will be difficult to repair and cracking can be expected to continue over a pe iod of years. (2) Settlement will result in some loss of freeboard and it will be necessary to add fill to the tops of the levees to maintain the pr sent freeboard. This added height will reduce the stability of the water si e slopes.

Be ause the island floors are subsiding and the differential water head on th levees is increasing, it will be necessary eventually to strengthen th levees. Constructing a berm adjacent to the levees appears to be pe haps the best method of strengthening them, and the berm could be built of either mineral soil or compost. As compared to mineral soils, compost is lighter, and the same depth of fill would cause less settlement. On the other hand, mineral soils are stronger than compost, and equal buttressing effect could probably be achieved with a lower and less extensive berm. Therefore there appears to be little to choose between mineral soil and compost as berm materials on the basis of their engineering properties. It appears at the present time that, if a berm is to be built, it may as well be built of compost.

## Construction Procedures

The U. S. Army Corps of Engineers (1944, 1960), the California Department of Water Resources (1963), and Weber (1969), have summarized the lessons learned from many years of experience in placing fills on peat soils in the Delta. Careful attention to these lessons will undoubtedly result in reduced costs and greater success in any future construction operations. These lessons include the following:

(1) The peat cannot support heavy equipment. 12-ton trucks broke through the peat on the second or third pass over the same area. Small crawler tractors can move on the peat without breaking through.

(2) High fills, rapidly built, will cause failure of the peat. Fills exerting loads of about 500 psf can usually be built fairly rapidly without causing failure, but higher fills should be built slowly enough so that the load increase is no more than about 50 psf to 100 psf per week. With slow filling rates and gentle slopes, there should be no trouble in building a fill exerting a pressure of 1000 psf.

(3) The strong surface layer of the peat should not be disrupted. No clearing or grubbing should be done, except for removing trees and heavy brush. It would be more desirable to burn off heavy grass than to strip it. Where the surface of the peat must be broken, as for example for construction of drains, procedures should be used which minimize the disturbance.

(4) Construction on the peat should be limited to the dry season. It may be possible to continue construction of the berm throughout the year

by doing all the work that needs to be done directly on the peat during the dry summer months. With drains installed and the bottom 4 or 5 ft. of compost placed in the summer, perhaps the compost filling operations can be continued through the winter.

## Futher Studies Required

Ths study indicates that a compost berm probably would have a beneficial stbilizing effect on the Delta levees provided that effective procedures ca be found for dealing with the problems caused by the cracking of the leees due to nonuniform settlements. This is, however, only a preliminary stdy. The best methods of dealing with the cracking problem and other imortant questions will require further studies in the field. When a paticular site has been selected, a topographic survey, test borings and a horough reconnaisance should be made at the site. The conditions at th site should be compared to those assumed in this feasibility study to deermine the applicability of the results of this study to the site seected. If portions of this study are inapplicable to the actual conditins at the selected site, additional studies will be required.

If it is decided to construct a test berm the following studies should be unertaken:

1 Settlements, horizontal movements, and spreading of the levee crest should be monitored carefully during the entire project. Construction should be halted if the settlements exceeds those predicted or if the lateral movement of the water side of the levee crest exceed 0.5 ft. Construction should only be resumed if a careful study indicates that failure of the levee is not impending.

(2 A thorough program of crack surveillance and repair should be conducted continually during construction and after construction. The best method for detecting and repairing cracks will require further study before and during construction, but it is clear that extensive cracking could weaken the levees considerably, and this matter will require very careful attention.

(3) Piezometric levels in the drains and in the peat beneath the berm should be observed to ensure that the water pressures are in fact maintained at low, safe levels by the drainage system.

(4) Densities and water contents of the compost should be measured on a regular basis, and supervision should be provided to ensure that the densities measured are representative of the entire fill.

(5) In-situ permeability tests should be performed in the peat, the compost and the drain materials using the falling head permeability procedure with standpipe piezometers.

(6) The settlements at the toe of the levee should be monitored to check the accuracy of the method of predicting settlements.

Many important questions can be answered only by performing field studies. These include:

(1) Can an effective program of crack surveillance and repair be developed so that the berm can be built safely?

(2) What is the best type of equipment for handling the compost?

(3) Will it be necessary to wet the compost or dry it out to improve compaction?

(4) Will the surface of the compost tend to dry out and become subject to wind erosion? If so, how can this be prevented?

(5) Can procedures be developed so that construction can continue in the wet winter months?

The test fill program, if undertaken, should be planned so that these questions are answered at the earliest possible stage.

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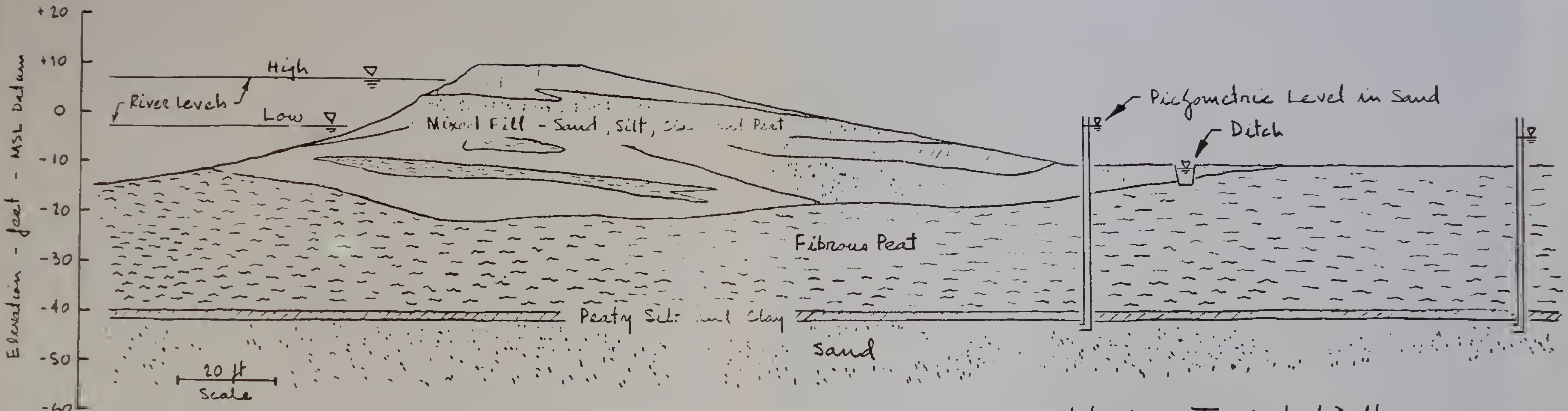
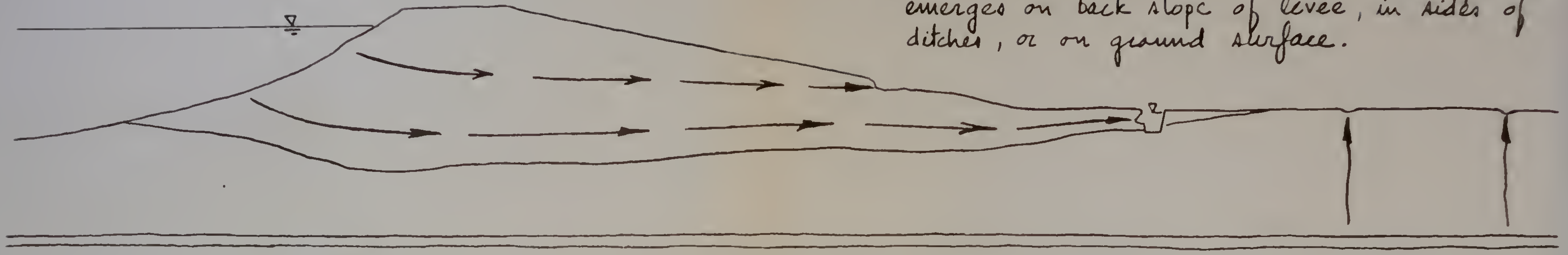


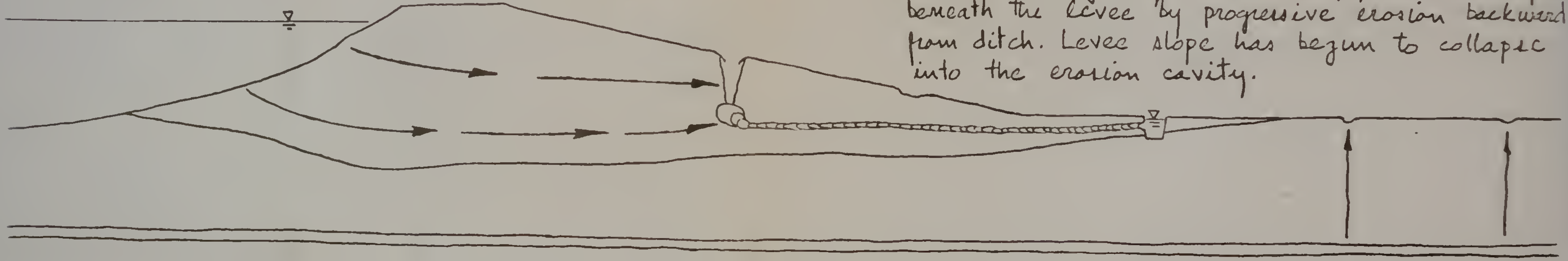
Typical Levee Conditions in The Central Delta

Compiled from Department of Water Resources
and Corps of Engineers Data

Figure 1



A. Erosion begins at points where seeping water emerges on back slope of levee, in sides of ditches, or on ground surface.

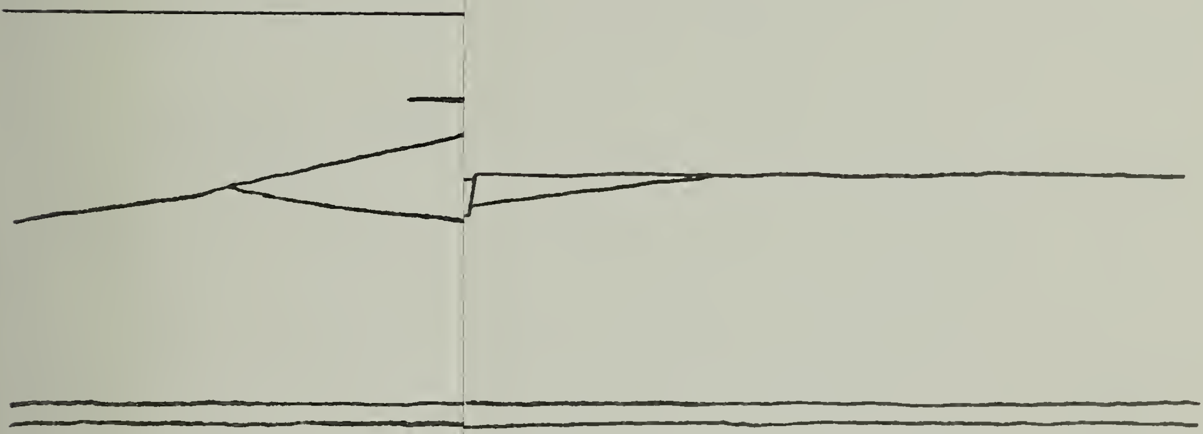


B. Advanced stage of erosion. A "pipe" has developed beneath the levee by progressive erosion backward from ditch. Levee slope has begun to collapse into the erosion cavity.

Mechanics of Erosion and Piping in Levees

Figure 2

landward side of the levee.
higher water level, tending
evee out of position.
creases as water level rises,
f the levee inward, forming

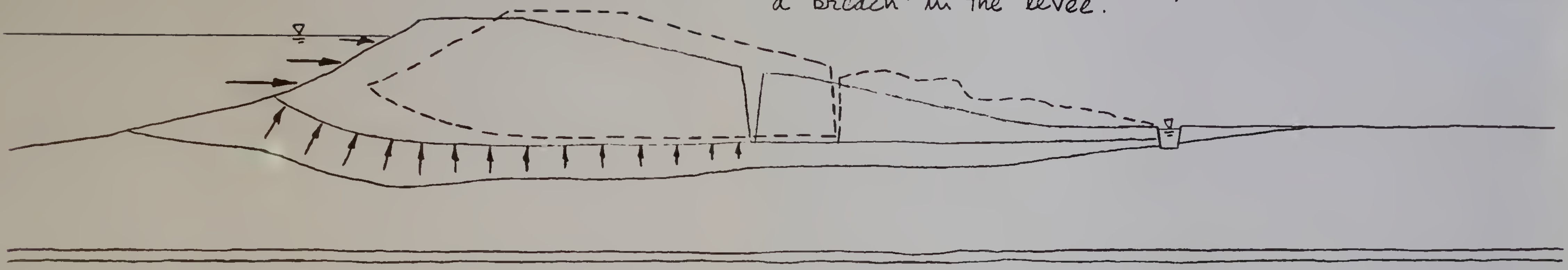


ure

Figure 3

Events tending to levee failure:

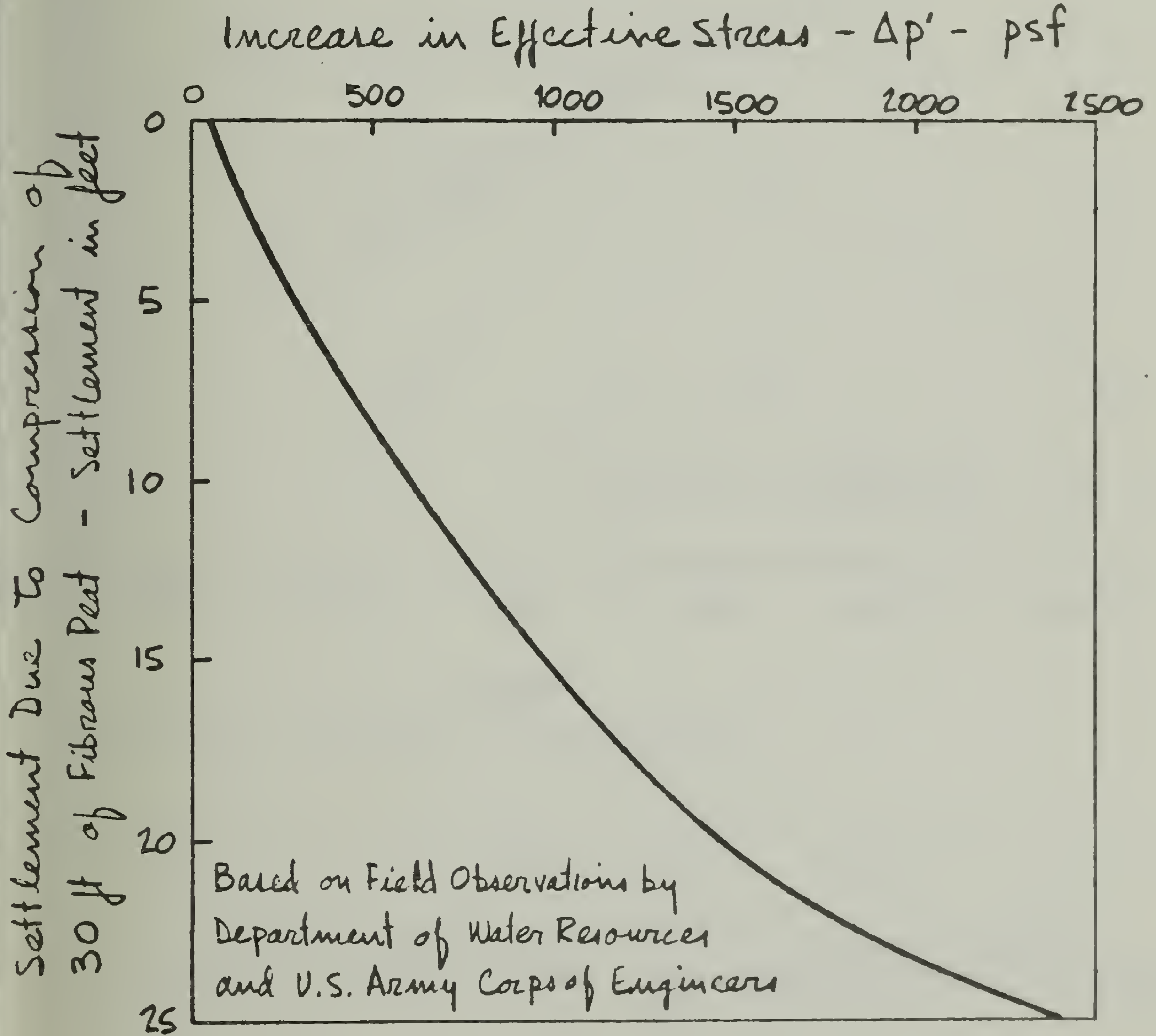
1. Erosion and piping weaken landward side of the levee.
2. Uplift pressure increases due to higher water level, tending to float the water side of the levee out of position.
3. Horizontal thrust from water increases as water level rises, and finally shoves a section of the levee inward, forming a breach in the levee.



Mechanism of Levee Failure

Figure 3

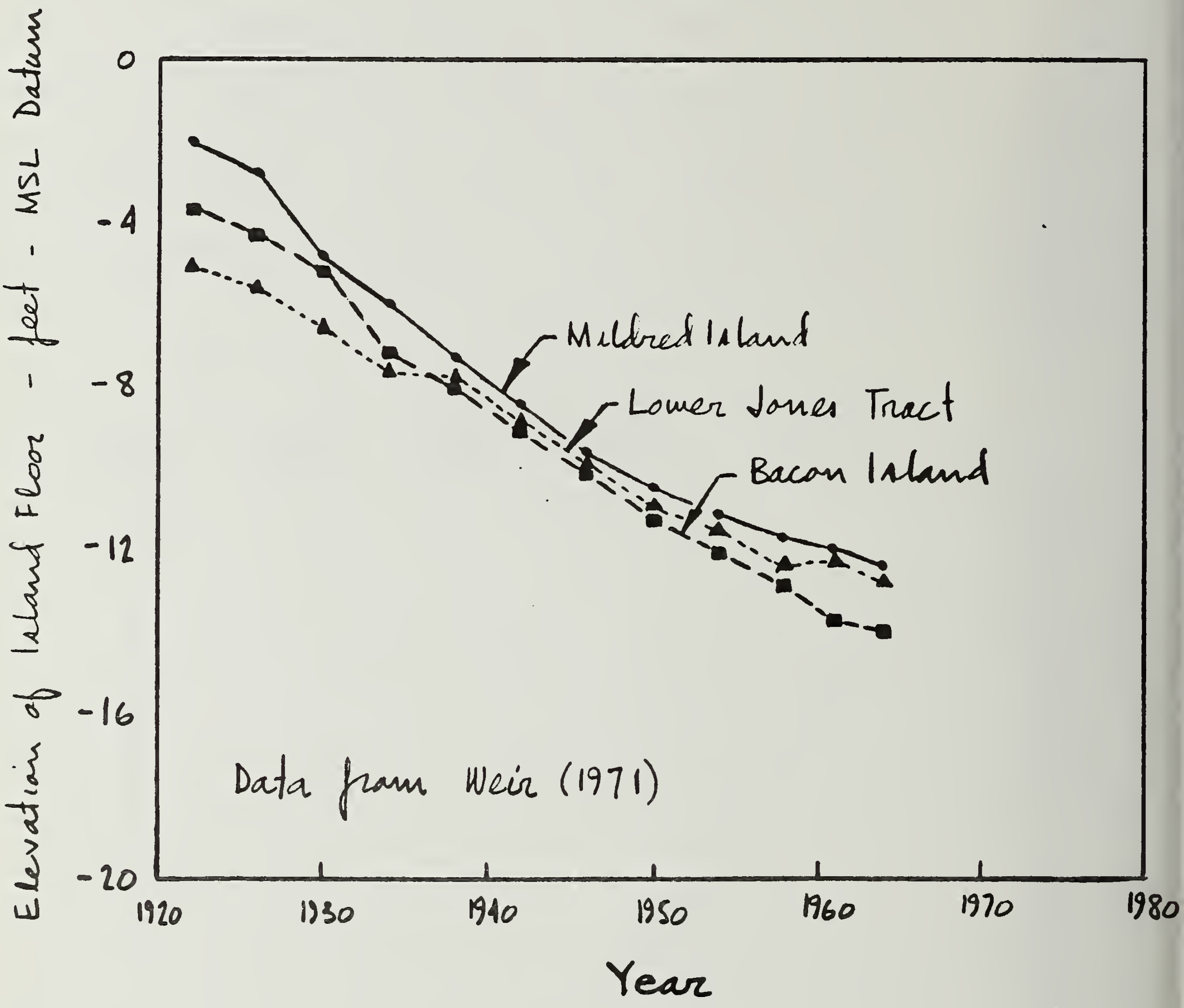
| Type of Fill | Thickness of Fill<br>5 ft | 10 ft | 15 ft | 20 ft |
|---|---|---|---|---|
| Sands and Silts above water | Δp' = 550 psf | Δp' = 1100 psf | Δp' = 1650 psf | Δp' = 2200 psf |
| Sands and Silts below water | Δp' = 250 psf | Δp' = 500 psf | Δp' = 750 psf | Δp' = 1000 psf |
| Compost above water | Δp' = 325 psf | Δp' = 650 psf | Δp' = 975 psf | Δp' = 1300 psf |
| Compost below water | Δp' = 25 ps | Δp' = 50 psf | Δp' = 75 psf | Δp' = 100 psf |



Based on Field Observations by Department of Water Resources and U.S. Army Corps of Engineers

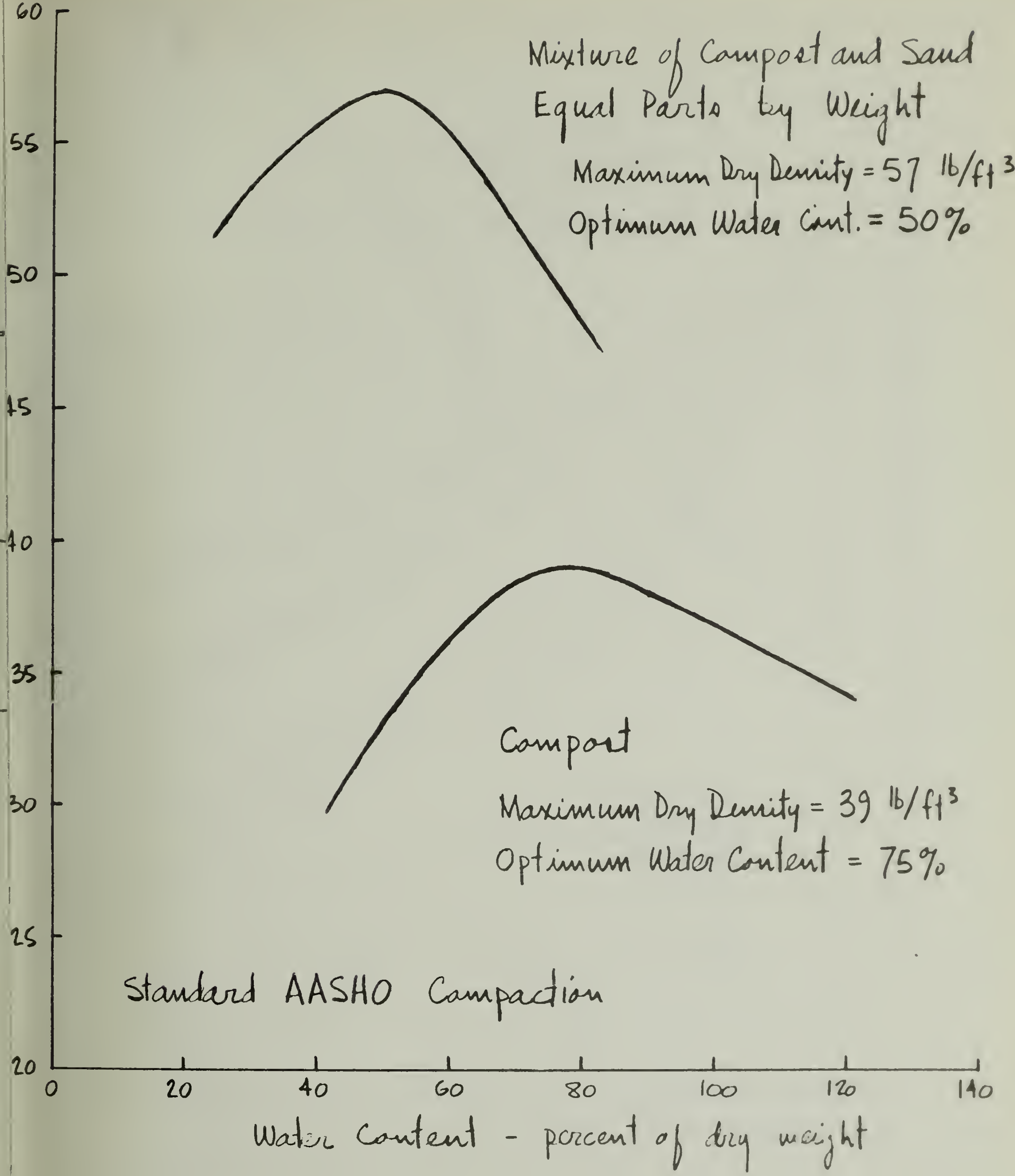
Settlement of Fills Placed on Fibrous Peat

Figure 4



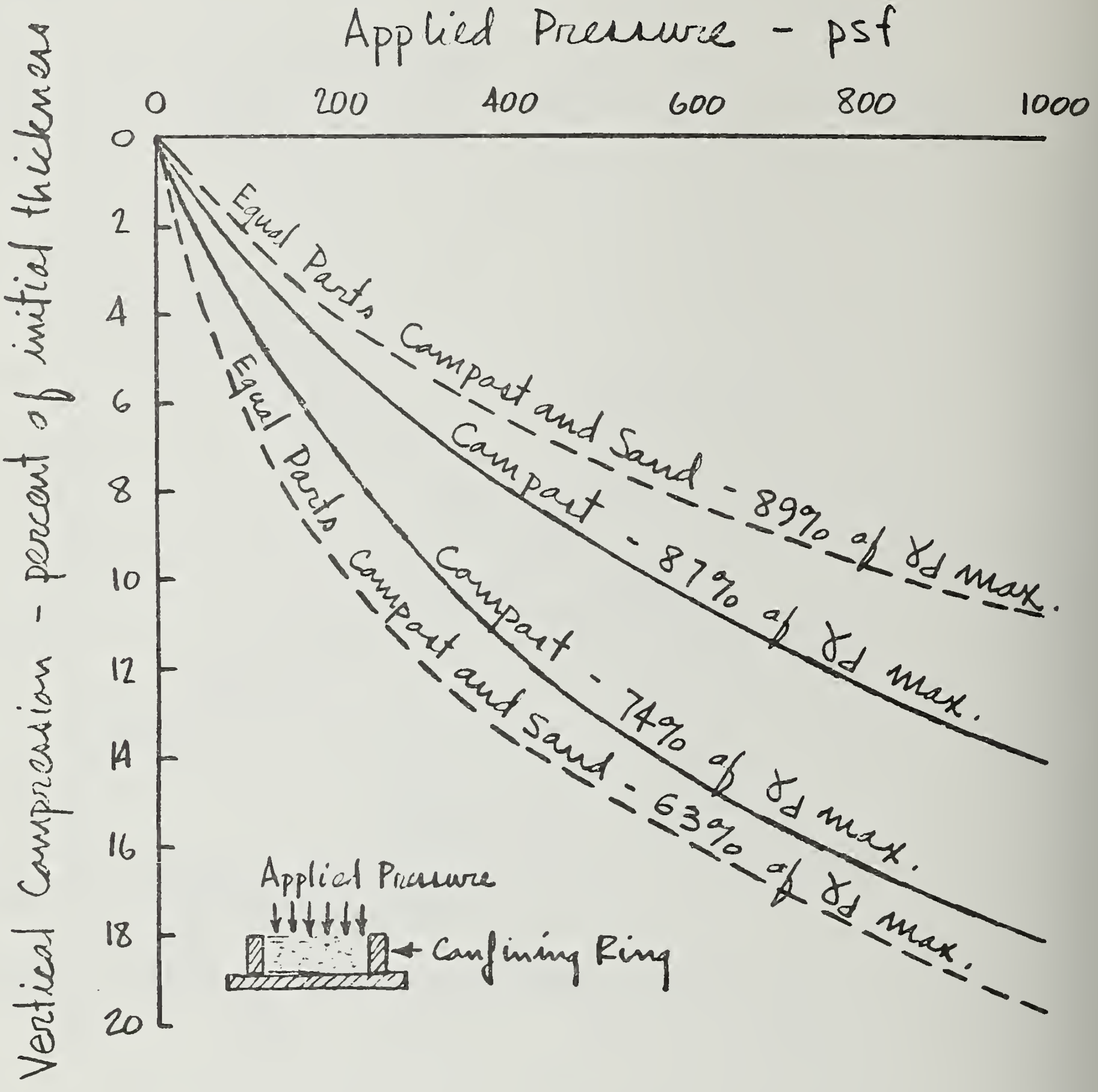
Gradual Subsidence of Three Delta Islands

Figure 5



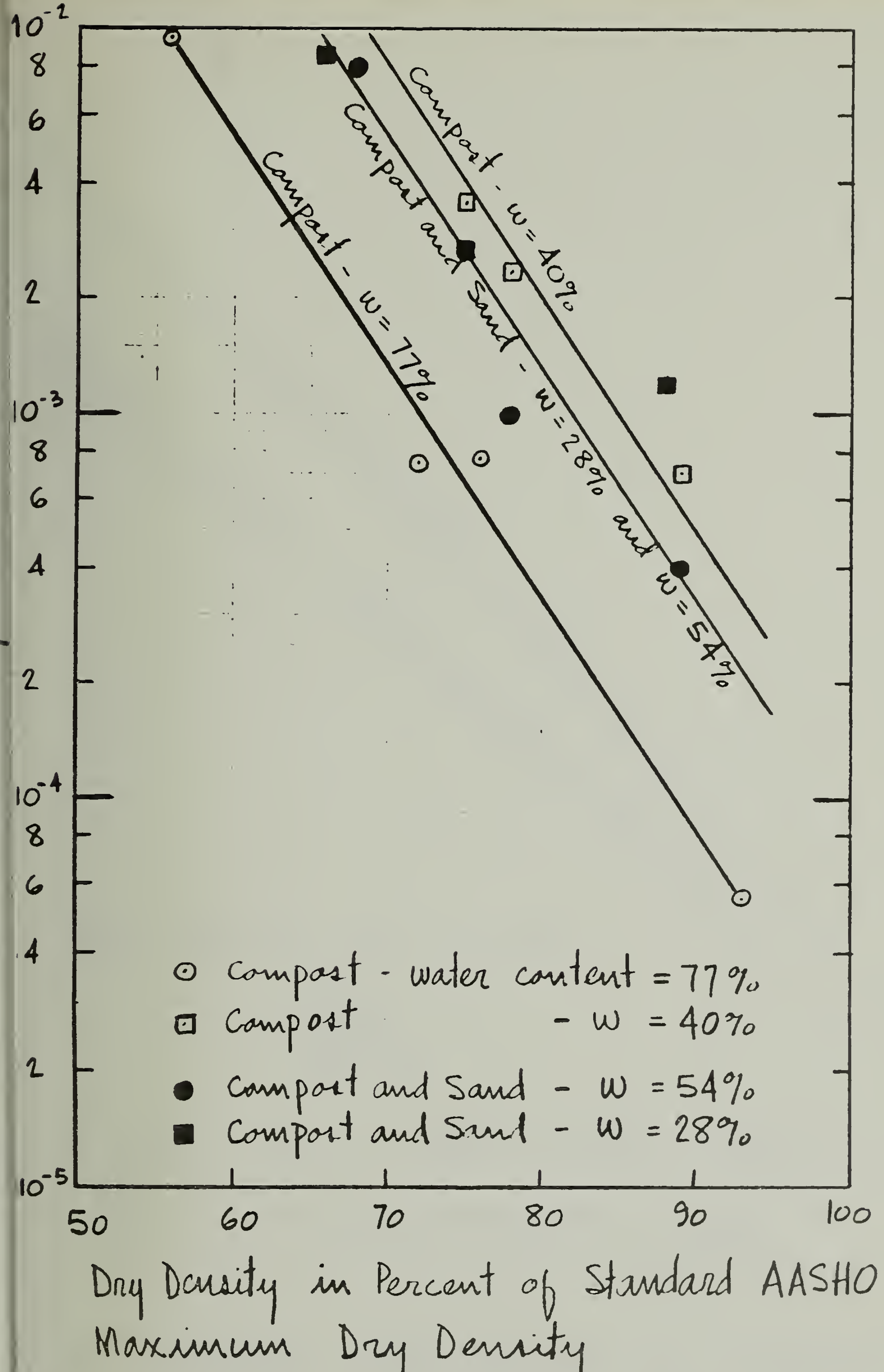
mpaction Characteristics of Compost and Mixture
Compost and Sand

Figure 6



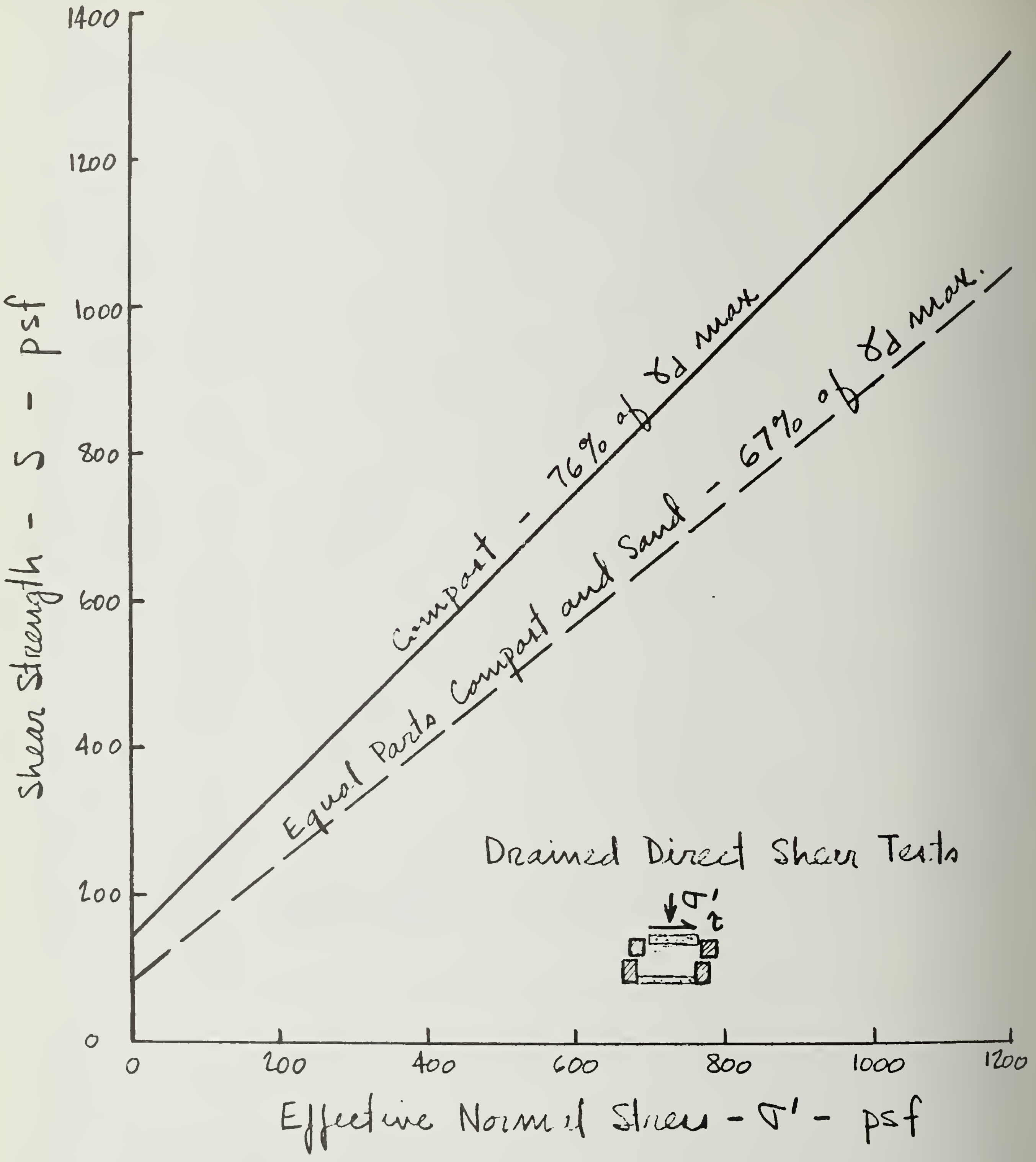
Compression Curves for Compost and Mixture of Compost and Sand.

Figure 7



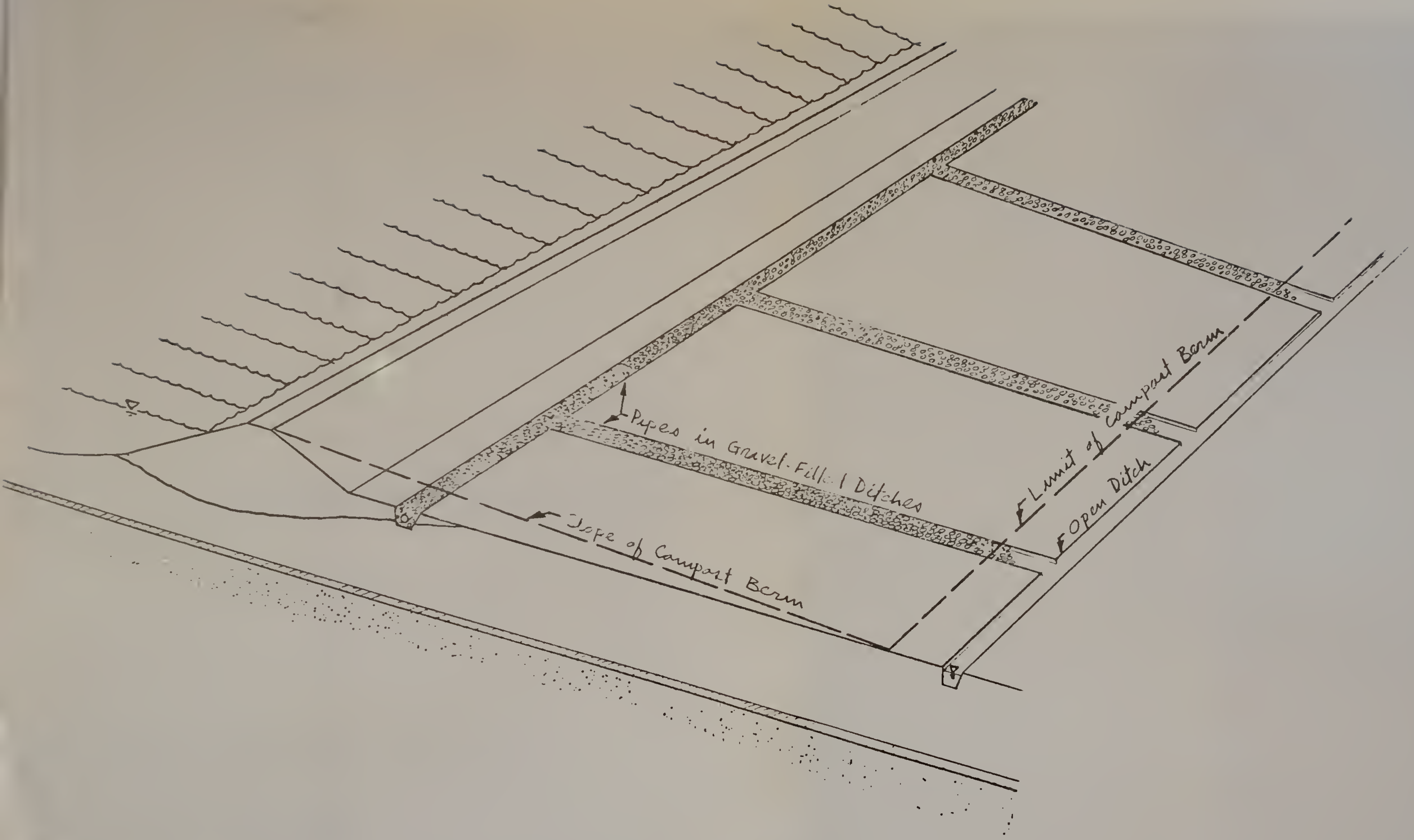
rmeability of Compost and Mixture of Compost
nd Sand

Figure 8



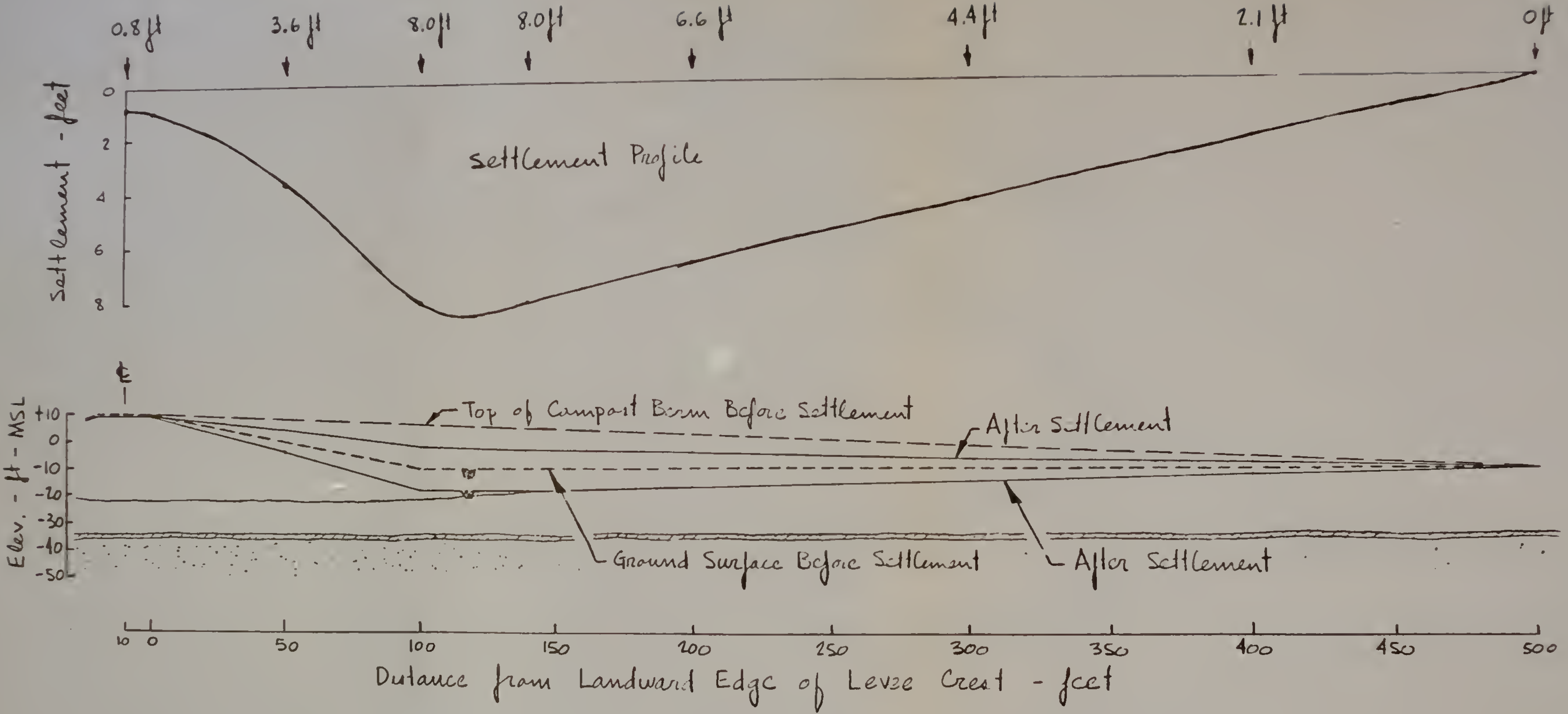
Shear Strength of Compost and Mixture of Compost and Sand

Figure 9



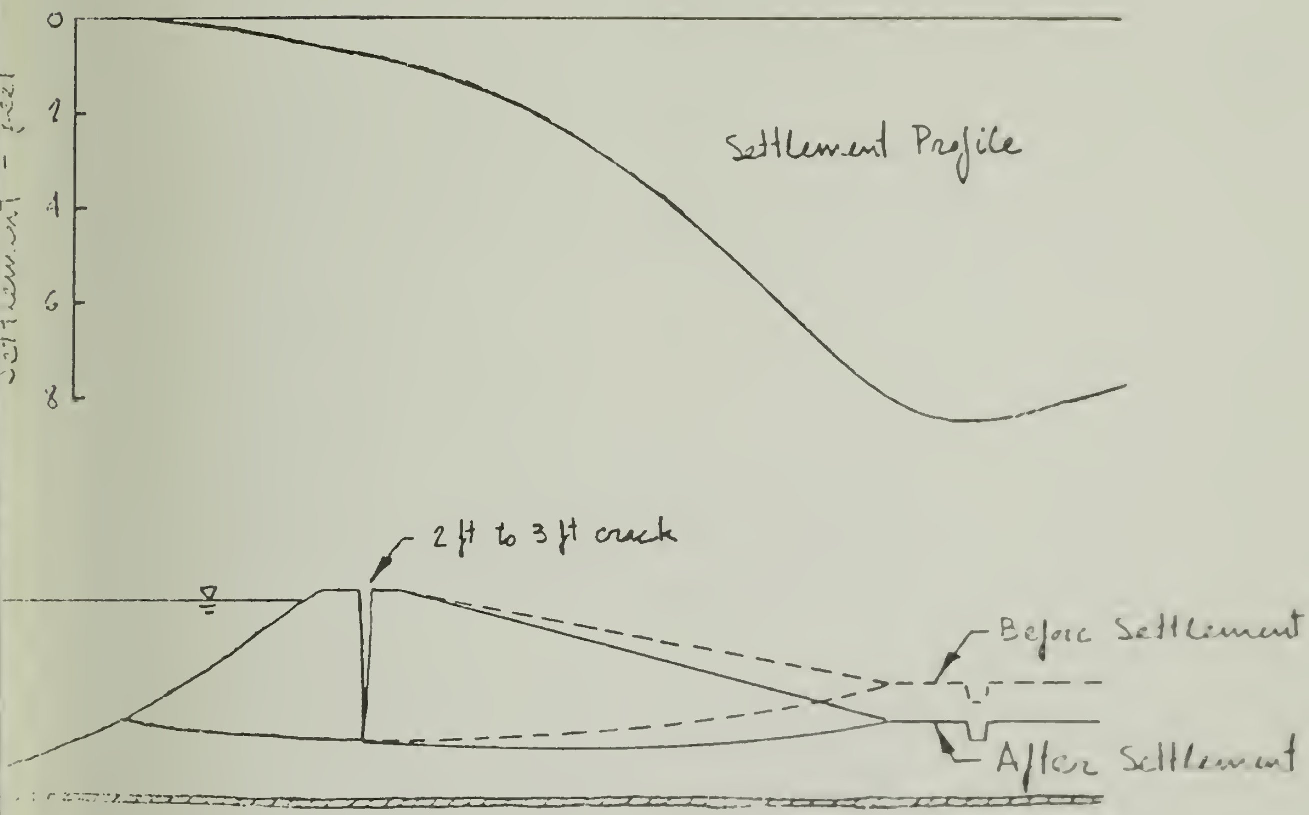
Subdrain System For Compost Berm

Figure 10



Settlement Due To Weight of Compost Berm

Figure 11.



Cracking Due to Nonuniform Settlement

Figure 12

## Appendix A

# Characteristics of Screened-Compost Material Used as Soil

University of California
Department of Civil Engineering
CE 299 - Individual Research

Presented by: Celso Ugas
for Professor J. M. Duncan

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## Synopsis

This paper shows the results obtained from laboratory tests on a new material which is a mixture of shredded municipal refuse and sewage sludge. This material will probably be used as soil in an effort to stabilize the levees in the Delta of the Sacramento and San Joaquin rivers.

Some characteristics such as compaction and compression of this material are presented, as well as values of permeability and drained shear strength for different water contents and dry densities. In addition, some physical properties are described.

## Introduction

The Delta, located at the confluence of the Sacramento and San Joaquin rivers, is in the west-central part of the Great Valley of California. It covers an area of about 415,000 acres of land, referred to as Delta Lowlands, lying between the elevations of 5 feet above and 20 feet below sea level. This area is composed of peat, organic sediments, and mineral alluvium. Most of the organic soils have been reclaimed by protection from overflow by man-made levees. An intricate system of natural drainage channels and artificial channels form a large number of islands, or so-called tracts.

The Delta is divided into more than sixty definitely named islands and tracts, each a complete reclamation unit or district with levees, drainage systems and irrigation facilities.

There are approximately 1,100 miles of levees throughout the Delta. Most Delta levees are founded on and constructed of locally available, unconsolidated peats and silts of low density, low shear strength and high moisture content. An exception is in the rim land areas, where sandy silts are encountered, and along the main channels of the Sacramento and San Joaquin rivers, where river sands are available (Department of Water Resources (1963).

lte levee failures have occurred usually involving from 200 to 1,000 f levee. The problem actually faced is the stability of existing e with economically feasible methods of maintenance or corrective tent to prevent possible failures of reaches of levee.

lres result in flooding of an entire island, often causing the lte loss of valuable crops. Closing the levee break and reclaiming island by pumping are additional expenses," (U. S. Engineer Office, )

d due to levee overtopping are infrequent in the central portion of Delta.

ly, the Delta levees are being maintained by various methods, ring to the ideas of the local man in charge; in many cases however, maintenance is not good enough to prevent failures.

## e

tw major issues in levee design in the Delta are stability and consolion for this reason a new material to be used as a stabilizer without easing the settlement so appreciably has been proposed as a solution. report shows some of the physical, hydraulic and mechanical properties the new material, as well as properties of the mixture of this material sand.

se properties may be useful for analytical analysis and/or as a basis further research.

## erial Tested

ne material is obtained as the product of composting of shredded icial refuse (30 cubic yards) and sewage sludge (3700 gallons). This tur received four turnings during two months being afterwards screened oug a 3/4" shaker screen (Hart, 1973).

the end of this process the material is quite brown, light in weight, , and friable with a faint soil-like odor; it will be referred to in s report as "screened-compost" or simply "compost".

Additional physical properties of the screened-compost determined in the laboratory are the following:

a) Water content

No change in dry weight or any burning of the material was noted after drying the material in an oven for 24 hours at 140°F or 230°F.

| Temperature | Water Content, w (%)* |
|---|---|
| 140°F (60°C) | 79.5 |
| 230°F (110°C) | 85.7 |

*Average of five values or more determined on the material as it was brought to the laboratory.

b) Unit weight.

The moist unit weight of the screened-compost, in a loose state as it was brought to the laboratory, is:

$$\gamma_m = 18.3 \text{ pcf } (0.294 \text{ gr/cm}^3)$$

c) Grain size distribution.

Several samples of screened-compost were dried in the oven at 230°F and then screened through different size sieves. In Fig. A-1 an average grain size distribution curve is shown, as well as the corresponding curve for the Bay Delta Sand, which was mixed with the screened-compost for some parts of the testing program.

d) Microscopic and macroscopic observations.

The particles passing the No. 4 (4.76 mm) sieve were observed through the microscope, with an enlargement of 450 times the real size. The material showed a predominantly fibrous structure composed by small pieces of: newspaper, plastic, glass, clothes, aluminum foil, plastic foil, leaves, straw, and soil. The maximum size of particle was 3/8" (9.51 mm), corresponding to pieces of newspaper mainly. The material passing the No. 100 (0.149 mm) sieve is dust-like.

## Description of Investigation

In order to determine some characteristics of the screened-compost material, and a mixture of screened-compost with sand in the proportion 1:1 by weight valent to 4:1, compost:sand, by volume), the following set of tests arried out in the soil laboratory:

1 - Compaction
2 - Compression
3 - Permeability
4 - Direct Shear Strength
5 - Filter Behavior

ial Preparation

e tests mentioned above were performed on the compost material as brought to the laboratory, i.e., without additional screening. mpost was first ovendried at 230°F and then a certain amount of water red to achieve the desired water content was added at the same time aterial was turned in a mechanical mixer. In the case of the compost- mixtures, the sand was added after the water.

Preparation

in the compaction test where no particles were removed, particles er than about 5 mm, estimated by eye, were removed in preparing the specimens.

following pages a test description including sample preparation een indicated for each particular test performed.

escription and Results

mpaction.

e standard AASHO test was performed on both materials: compost and mpost-sand mixed 1:1 by weight. The procedure was as usual, so e material was placed in a 4" diameter mold and compacted in three ayers with 25 blows on each applied with a hammer of 5.5 lb. (2.45 kg) d 12" (30.5 cm) free-fall.

e results are summarized in Fig. A-2. Both curves have shapes pical of clay soils.

e values of optimum water content and maximum dry density obtained e:

| Material | $w_{opt}$ % | $\gamma_{d\ max}$, pcf (gr/cm$^3$) |
|---|---|---|
| Screened-compost | 75 | 39.0 (0.625) |
| Compost and sand<br>(Mixture 1:1 by weight) | 50 | 57.0 (0.913) |

On the basis of these results a program for material testing conditions was established involving samples prepared at densities of 90% $\gamma_d$ max and 75% $\gamma_d$ max and water contents of $w_{opt}$ and $w_{opt}/2$. The main purpose of this program was to determine how the properties of the material are affected when changes in water content and/or dry density occur. These testing conditions are shown in Fig. A-2.

2. Compression.

Tests were carried out on non-saturated samples with characteristics as shown in Fig. A-2. In order to get the appropriate density, the material was placed into the mold in three layers and each of these were compacted under pressure applied through the Universal compression machine. However, only hand-applied pressure was required for the compost-sand material to achieve densities equal to or less than 75% $\gamma_d$ max.

Samples were placed into rings of 4" (10.16 cm) diameter and 1" (2.54 cm) high. The loads were applied in increments, being doubled in every increment, starting from 5.5 lb. (2.5 kg) up to 88.3 lb. (40 kg), i.e., from 0.44 psi (0.031 kg/cm$^2$) up to 7.03 psi (0.495 kg/cm$^2$). This range of pressures allows consideration of embankments up to 20 feet high.

During preliminary tests the load was left for two hours (see Figs. A-3, A-4), but it was noticed that most of the deformation occurred during the first minute; therefore it was concluded that leaving every load increment for ten minutes might affect the results by less than 3%. In consequence all subsequent tests were performed with load increments every ten minutes.

Every test was duplicated in order to get average values to draw the compression curves which are shown in Figs. A-5 through A-8. All these curves were plotted together in Fig. A-9, where it may be noticed that variations in initial water content ($w_i$) do not yield a considerable change in the amount of compression ($\varepsilon$). It may also be observed that for the compost material, an increment of 5 pcf in dry density may yield a maximum of 6% less in compression at pressure of 7 psi.

In Fig. A-9 it is also observed that for the high density range the amount of compression is about 3% less for the compost and sand material than for the compost at 7 psi of pressure. For the low density the inverse is true and the difference is only 1.5%. Therefore there is no significant difference in the amount of compression yielded by either of the tested materials, at least under the conditions here established.

The changes in dry unit weight under vertical pressures are shown in Figs. A-10 and A-11. Here again there is no influence of the water content on the variation of dry density due to the fact that $\gamma_d$ increases with compression but compression is not affected by water content as shown previously.

The variation of dry unit weight with pressure is essentially linear and equal to 0.80 pcf per 1 psi (144 psf). This is true for pressures equal or greater than 1.5 psi and any of the conditions shown in Figs. A-10 and A-11.

3. Permeability.

Falling head permeability tests were carried out for different water contents and three different densities.

Samples were placed in a loose state and then compacted in the specimen holder with a wooden stick.

Values of permeability for different initial water contents are shown as a function of dry density in Fig. A-12a. In this figure it may be seen that different initial water contents and dry densities may change the permeability values for the compost material; it is also observed that for the same density, the lower the initial water content the larger the permeability. For the compost-sand mixture however, different initial water contents yield the same permeability value.

The data in Fig. A-12b shows that for the same percent of maximum dry density, values of permeability are higher for the compost with

$w_i$ = 40% than for the compost-sand material. However, for $w_i$ = 77% the opposite is true, with permeability values of $4.2 \times 10^{-3}$ and $5.3 \times 10^{-4}$ cm sec for maximum dry densities of 70% and 85% respectively. This means that permeability values are 4 or 5 times larger for the compost-sand mixture than for compost material with 77% initial water content.

4. Direct Shear Strength.

Drained direct shear tests were performed on samples with characteristics as indicated in Fig. 2; for each density and moisture condition three samples were tested at different normal pressures.

The sample dimensions were: length = width = 2" (5.08 cm), and variable height from 0.85" (2.16 cm) through 0.95" (2.42 cm).

The testing procedure was as follows: the sample container was flooded with water, then the normal pressure was applied so that the specimen was allowed to consolidate for a period of 30 minutes. After that, direct shear was applied to the material at a velocity of about 0.0067 inches/min.

Because there is no peak in the curves of horizontal displacement vs. shear stress (see Figs. A-13 and A-14), the shear strength has been considered in all cases as being the shear stress corresponding to 0.2 inches of horizontal displacement. On this basis, the drained strength envelopes have been drawn in Figs. A-15 and A-16. In these figures it is also shown that changes in water content do not change the drained strength of either of the materials tested, i.e. the amount of water has no influence on strength.

Both materials show high friction angles (45° and 46.5°), as well as reasonably good strength. It is also observed (see Fig. A-17) that for low densities the cohesion decreases appreciably.

From Fig. A-17 it might be concluded that, for the range of pressure shown, there is no significant difference in the shear strengths of the materials tested.

5. Filter Behavior.

In order to determine the effectiveness of the compost material working as a filter to prevent the washing out of silty soil particles through the compost, a kind of permeability test was carried out by placing the material as shown on Fig. A-18 and then allowing water to pass through the sample for three days. No observable amount of silt particles were washed out during these tests.

Conclusions

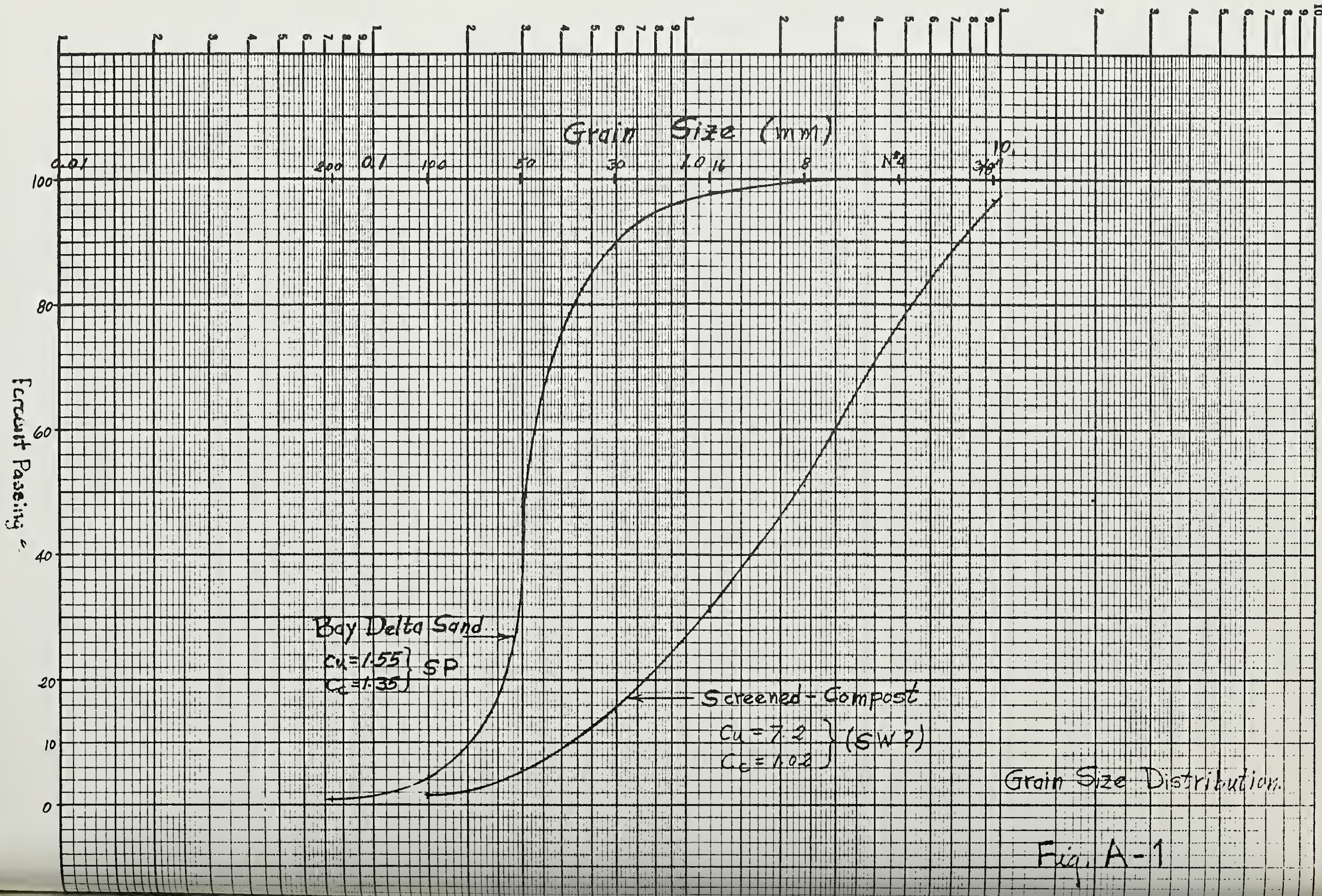
.. The initial water content has no significant effect on either the compression or the drained shear strength characteristics of the compost, but it does influence the permeability values. The lower the water content, the higher the permeability.

. As a rule of thumb, it might be said that at high pressures (7 psi) an increment of 1 pcf in the dry density may reduce the amount of compression of the compost by about 1%. For the compost-sand mixture, an increment of 1.5 pcf may reduce the compression by about 1%.

. The compressibility of the compost and compost-sand mixture did not differ significantly; therefore there is no advantage, at least in this respect, to mix the compost with sand. Furthermore, the use of the compost-sand mixture is not advisable because it has higher density than the compost. This would increase the amount of settlement in the peat soil, which is undesirable.

. The angles of friction for the compost (45°), as well as for the compost-sand (46.5°) are quite satisfactory. In addition, both materials show a cohesion intercept in the order of 1.0 to 3.7 psi at high densities. Again there is no major improvement of the compost strength by adding sand.

Mixing sand with the compost does not seem to improve the properties here studied.



Grain Size Distribution.

Fig. A-1

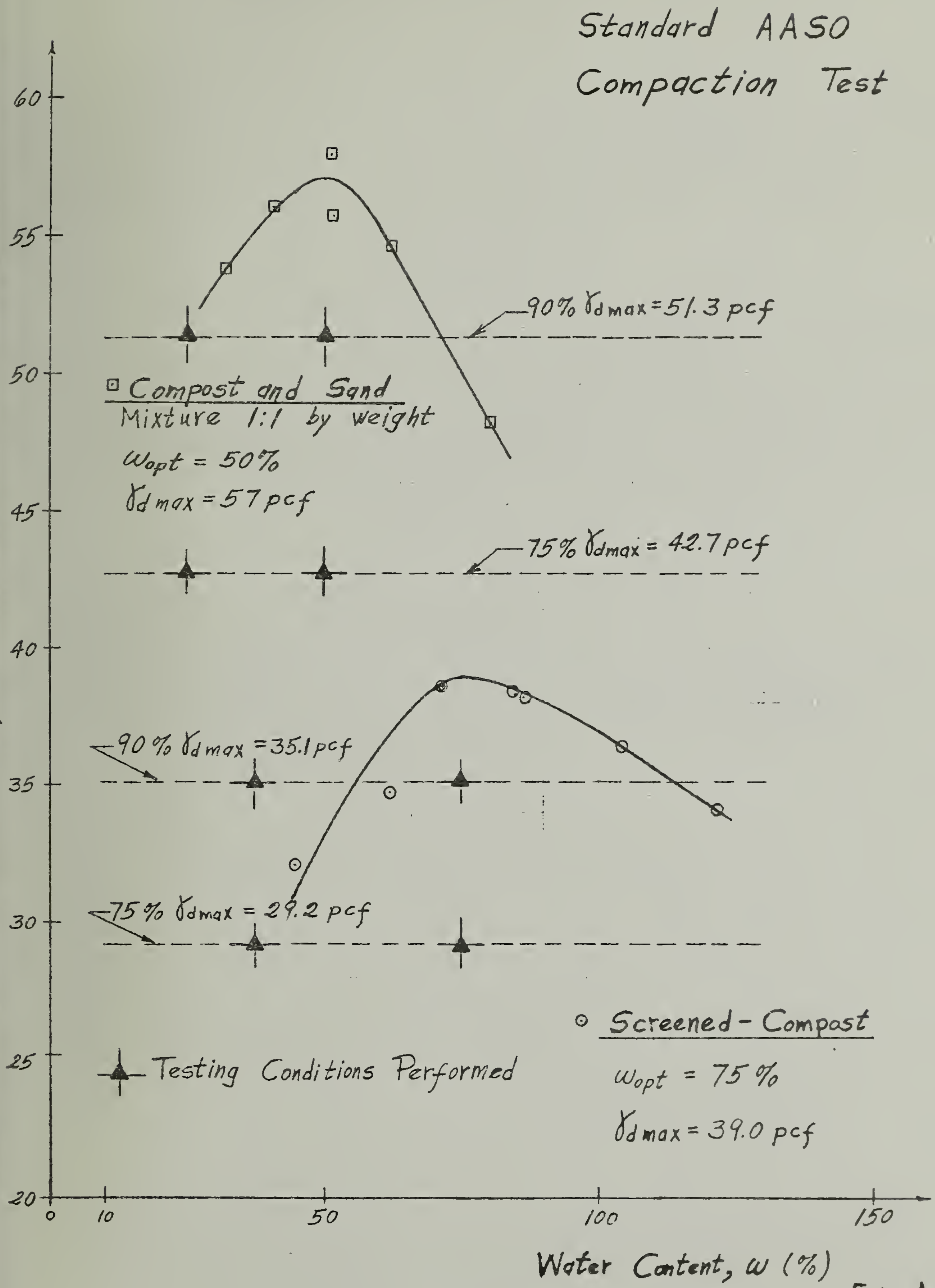

Standard AASO Compaction Test
60
55
50
45
40
35
30
25
20
0
10
50
100
150
Water Content, ω (%)
90% γd max = 51.3 pcf
75% γd max = 42.7 pcf
90% γd max = 35.1 pcf
75% γd max = 29.2 pcf
□ Compost and Sand
Mixture 1:1 by weight
ωopt = 50%
γd max = 57 pcf
⊙ Screened-Compost
ωopt = 75%
γd max = 39.0 pcf
▲ Testing Conditions Performed

Fig. A-2

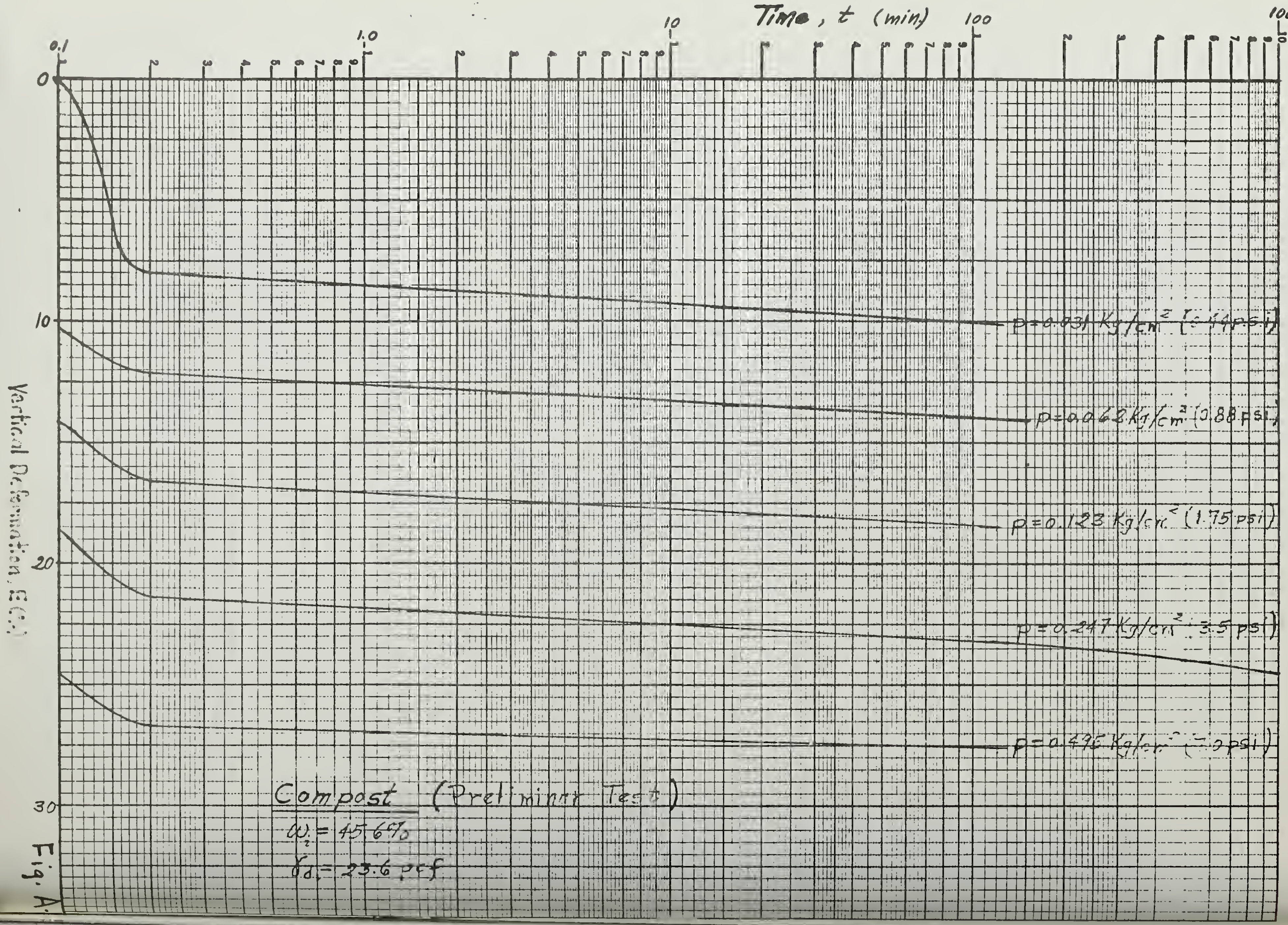

Time, t (min)
0.1
1.0
10
100
1000
Vertical Deformation, E(%)
0
10
20
30
p=0.031 Kg/cm² (0.44 psi)
p=0.062 Kg/cm² (0.88 psi)
p=0.123 Kg/cm² (1.75 psi)
p=0.247 Kg/cm² (3.5 psi)
p=0.495 Kg/cm² (7.0 psi)
Compost (Preliminary Test)
ω_i = 45.6%
γ_di = 23.6 pcf

Fig. A.

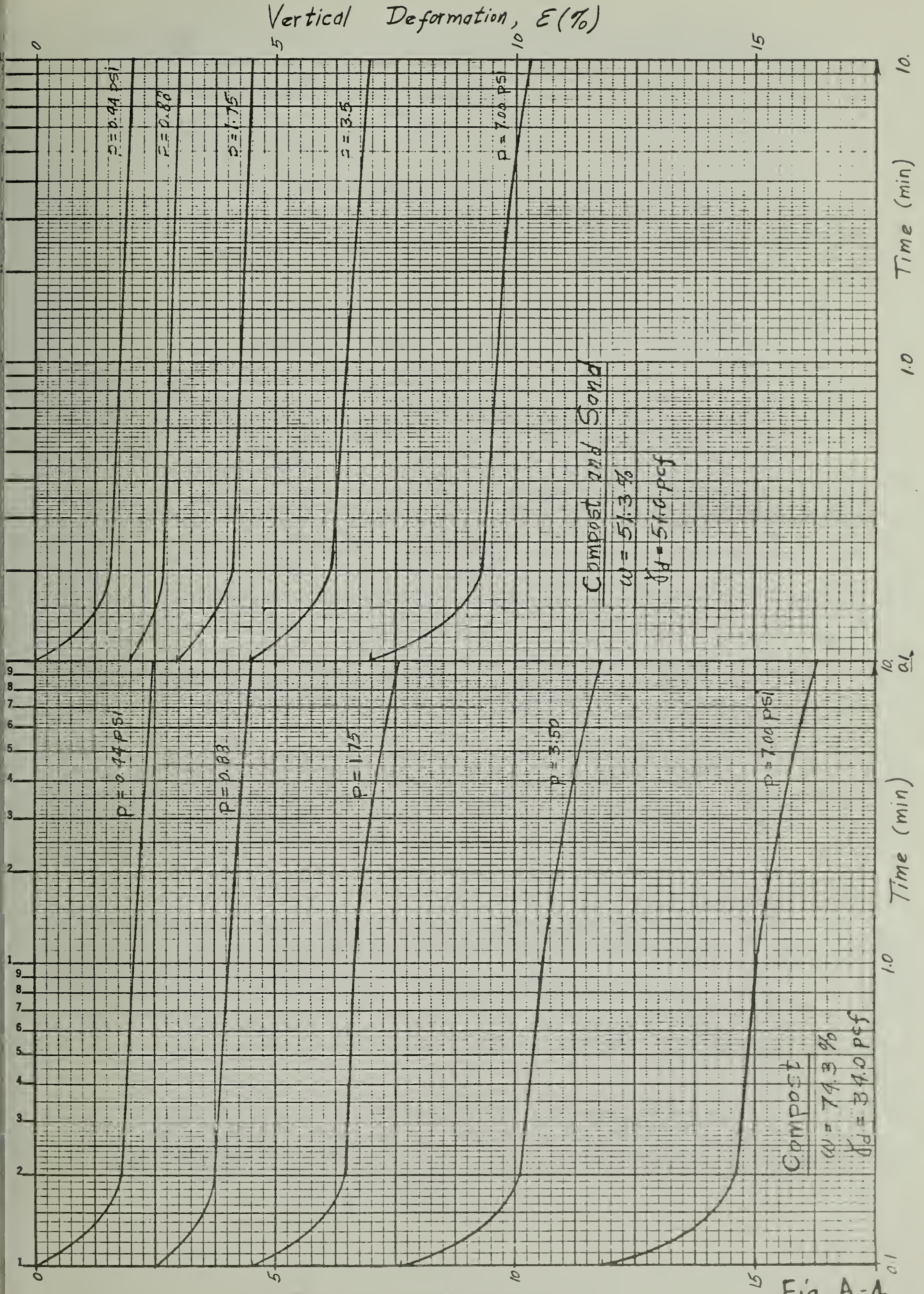

Vertical Deformation, E(%)
0
5
10
15
Time (min)
10.
1.0
0.1
Time (min)
10.
1.0
0.1
p = 0.44 psi
p = 0.88
p = 1.75
p = 3.5
p = 7.00 psi
Compost and Sand
ω = 51.3 %
γd = 51.0 pcf
p = 0.44 psi
p = 0.88
p = 1.75
p = 3.50
p = 7.00 psi
Compost
ω = 74.3 %
γd = 34.0 pcf

Fig. A-4

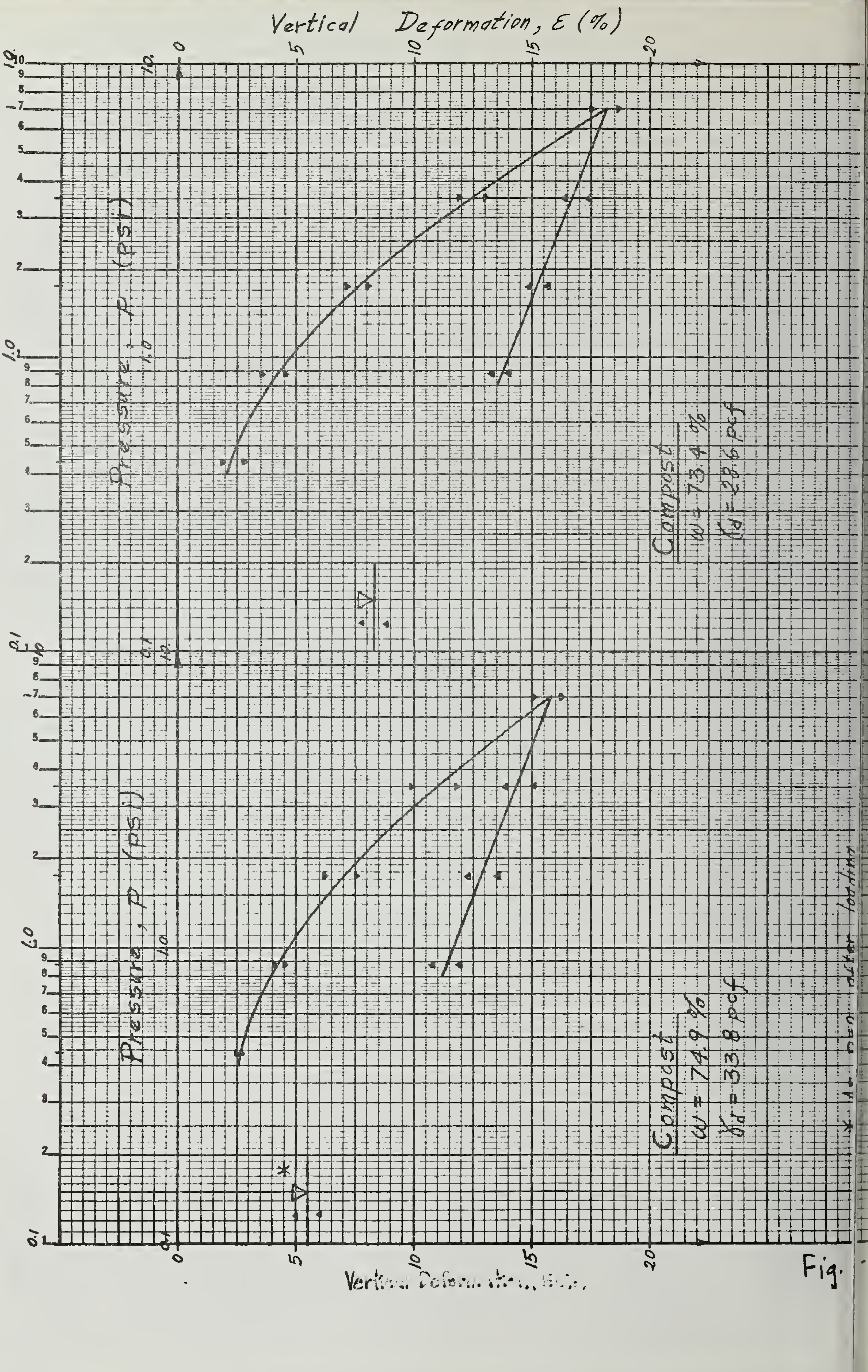

Vertical Deformation, ε (%)
0
5
10
15
20
Pressure, P (psi)
0.1
1.0
10
Compost
ω = 73.4 %
$\gamma_d$ = 28.6 pcf
Compost
ω = 74.9 %
$\gamma_d$ = 33.8 pcf
* 1st run after loading
Vertical Deformation, ε (%)

Fig. -5

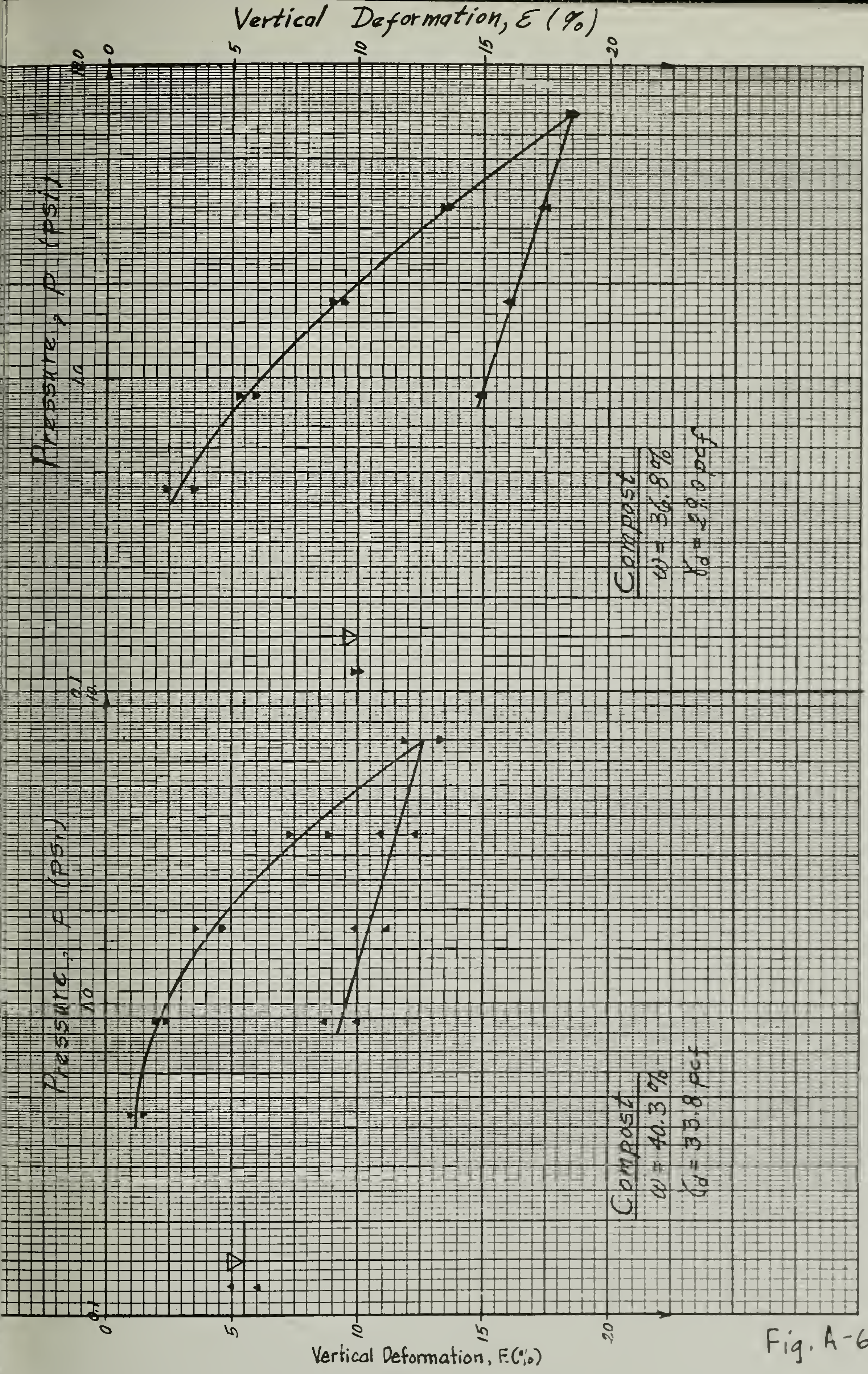

Vertical Deformation, ε (%)
0
5
10
15
20
Pressure, P (psi)
0.1
1.0
10
100
Compost
ω = 36.8%
γd = 21.0 pcf
Pressure, P (psi)
0.1
1.0
10
Compost
ω = 40.3%
γd = 33.8 pcf
0
5
10
15
20
Vertical Deformation, ε (%)

Fig. A-6

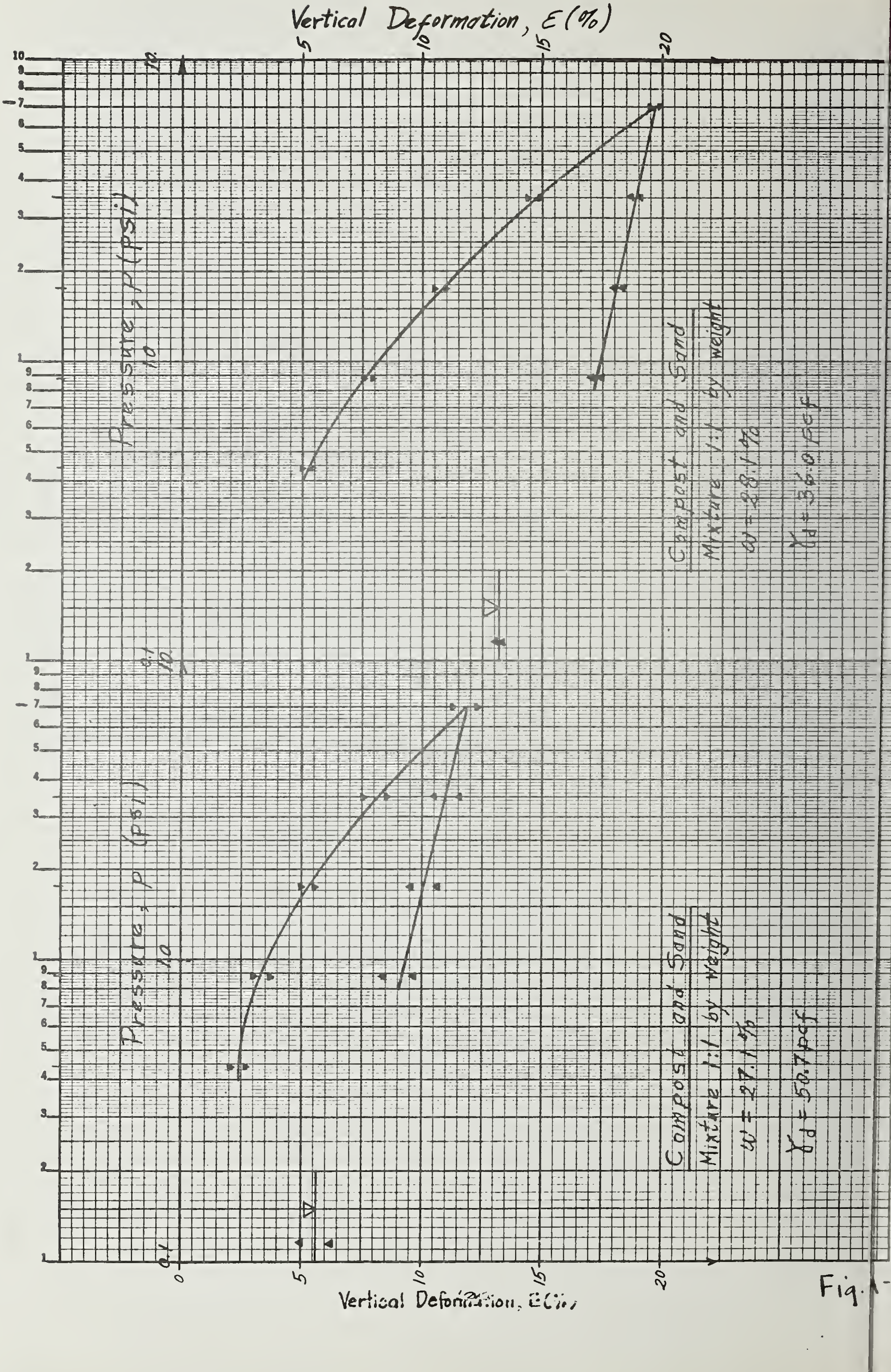

Vertical Deformation, ε (%)
5
10
15
20
Pressure, p (psi)
0.1
10
Compost and Sand
Mixture 1:1 by weight
ω = 28.1%
γd = 36.0 pcf
Pressure, p (psi)
0.1
10
Compost and Sand
Mixture 1:1 by weight
ω = 27.1%
γd = 50.7 pcf
0
5
10
15
20
Vertical Deformation, ε (%)

Fig. A-

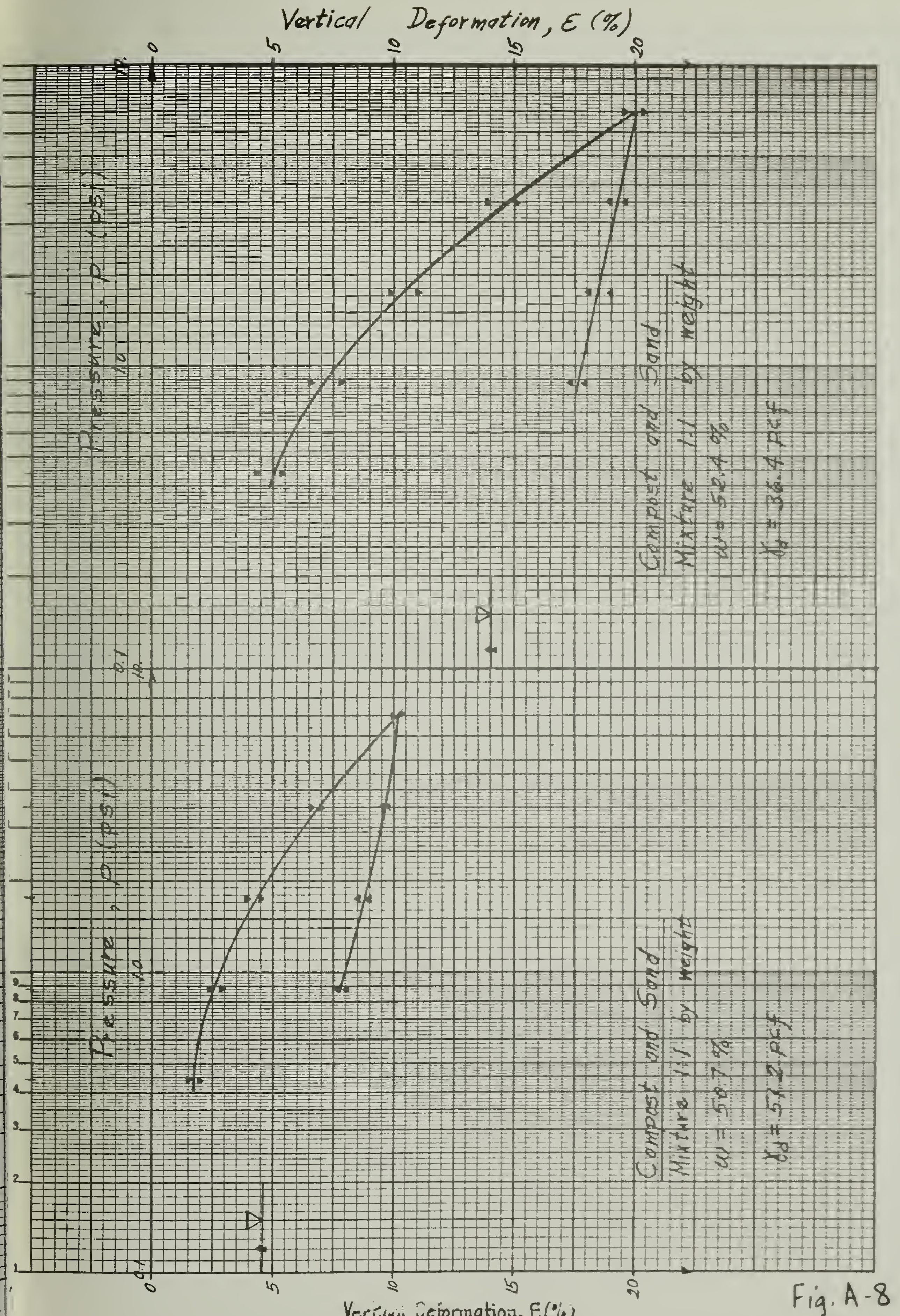
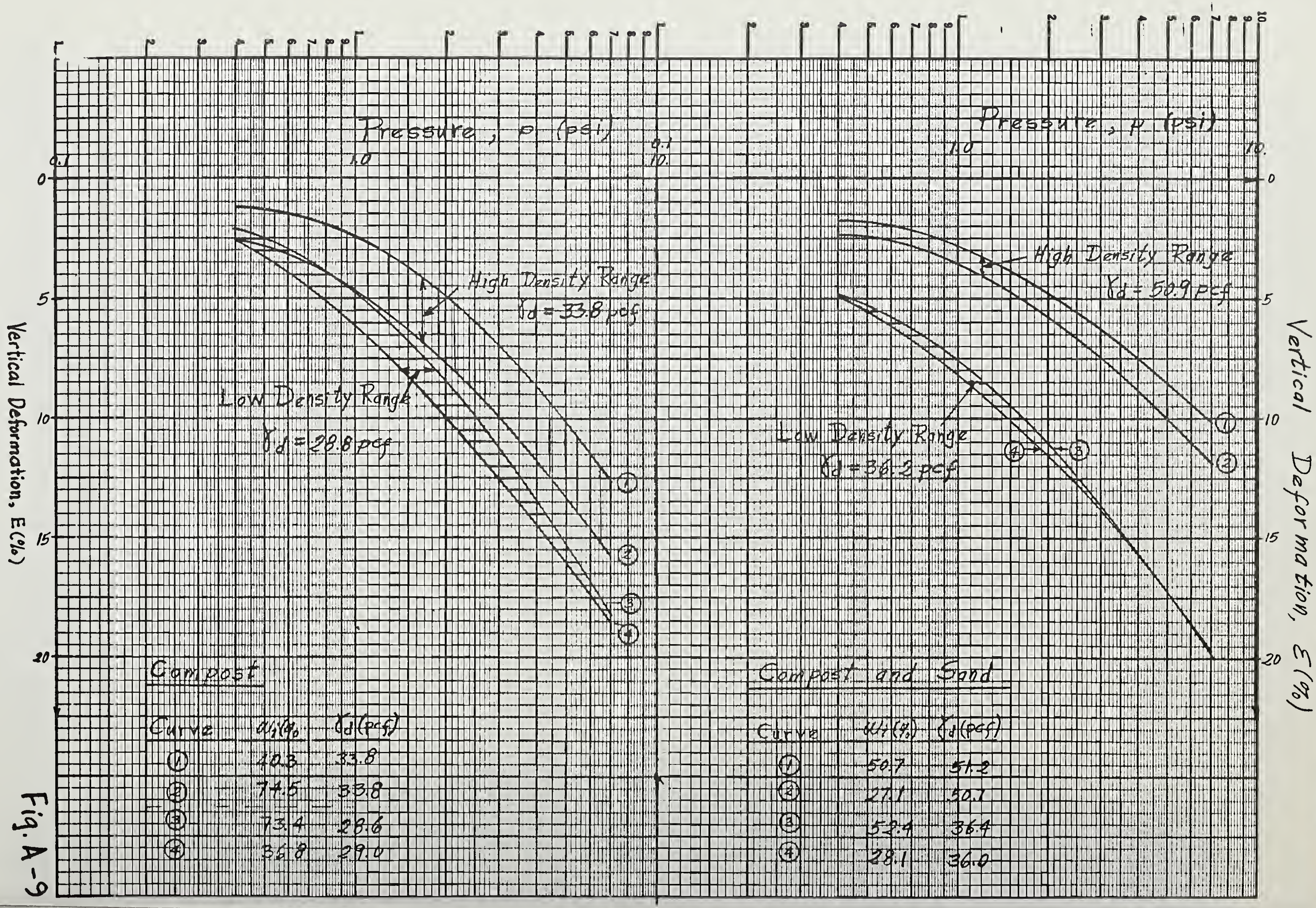

Vertical Deformation, E (%)
0
5
10
15
20
Pressure, P (psi)
10
0.1
10.
Compost and Sand
Mixture 1:1 by weight
w = 52.4 %
$\gamma_d$ = 36.4 pcf
Pressure, P (psi)
10
1
2
3
4
5
6
7
8
9
0.1
Compost and Sand
Mixture 1:1 by weight
w = 50.7 %
$\gamma_d$ = 51.2 pcf
0
5
10
15
20
Vertical Deformation, E(%)

Fig. A-8



Compost

| Curve | $w_i$(%) | $\gamma_d$(pcf) |
|---|---|---|
| ① | 40.3 | 33.8 |
| ② | 74.5 | 33.8 |
| ③ | 73.4 | 28.6 |
| ④ | 36.8 | 29.0 |

Compost and Sand

| Curve | $w_i$(%) | $\gamma_d$(pcf) |
|---|---|---|
| ① | 50.7 | 51.2 |
| ② | 27.1 | 50.7 |
| ③ | 52.4 | 36.4 |
| ④ | 28.1 | 36.0 |

Fig. A-9

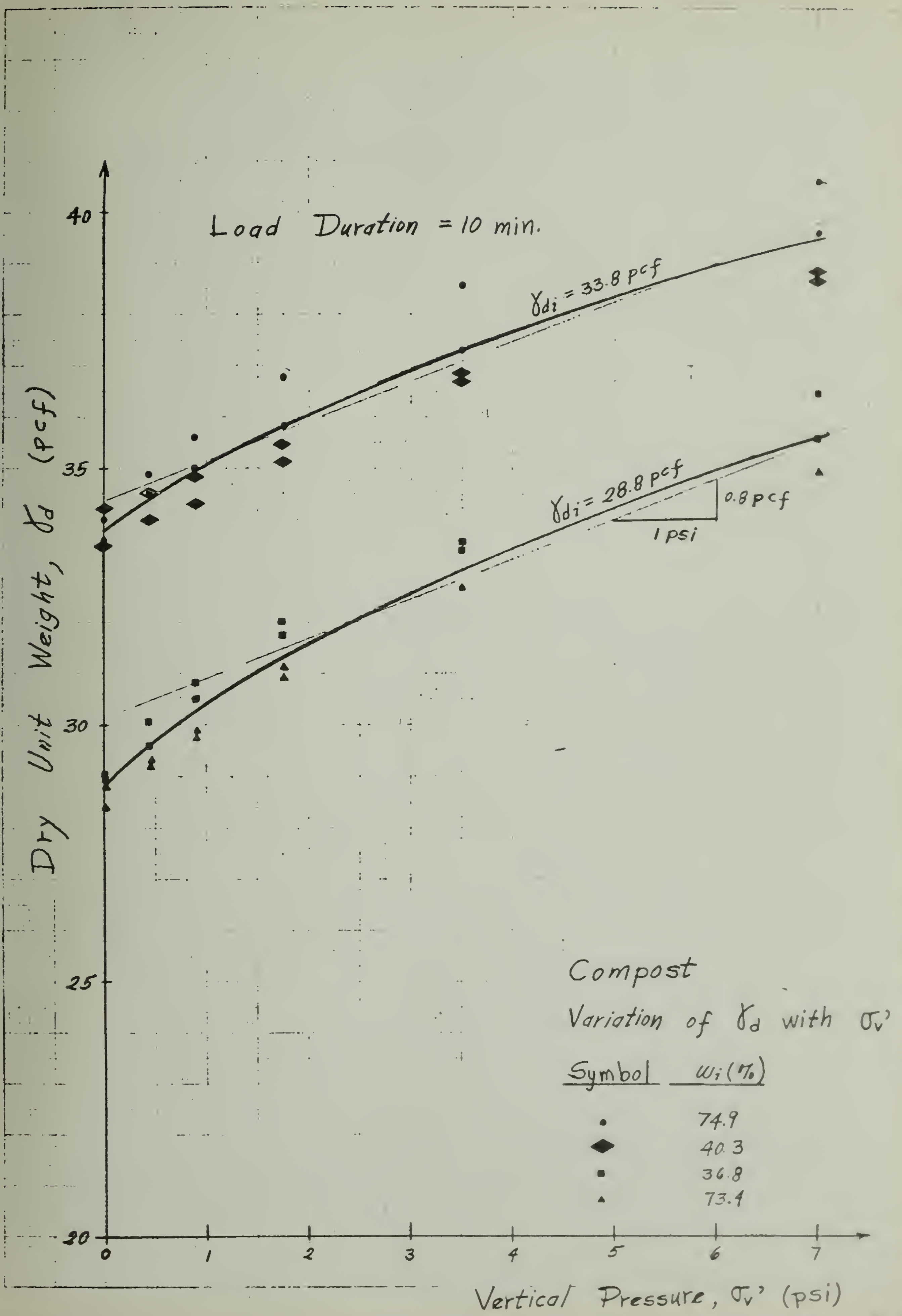

Load Duration = 10 min.
$\gamma_{di}$ = 33.8 pcf
$\gamma_{di}$ = 28.8 pcf
0.8 pcf
1 psi
Dry Unit Weight, $\gamma_d$ (pcf)
40
35
30
25
20
0
1
2
3
4
5
6
7
Vertical Pressure, $\sigma_v'$ (psi)
Compost
Variation of $\gamma_d$ with $\sigma_v'$
Symbol
$w_i$ (%)
● 74.9
◆ 40.3
■ 36.8
▲ 73.4

Fig. A-10

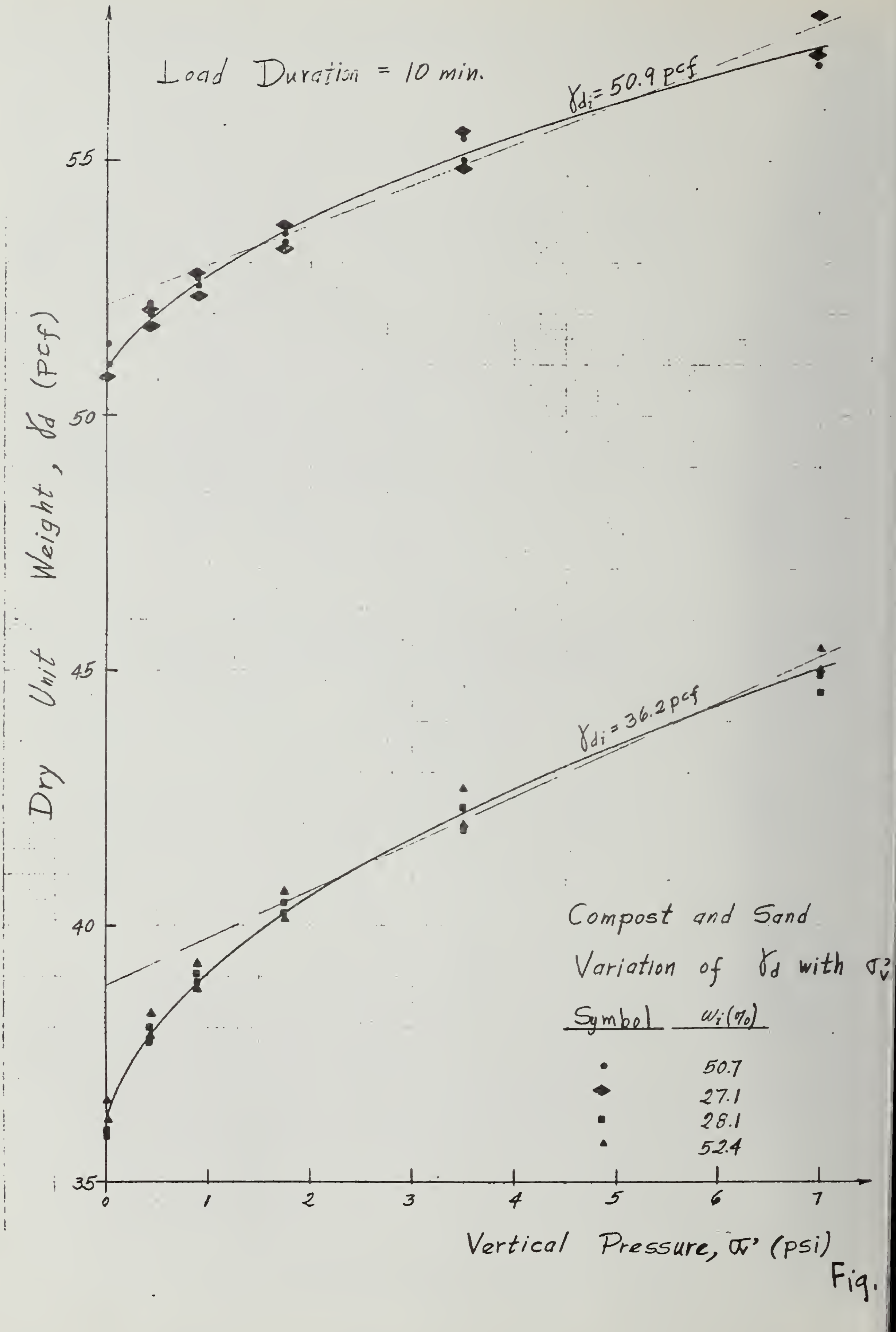

Load Duration = 10 min.
$\gamma_{d_i} = 50.9$ pcf
$\gamma_{d_i} = 36.2$ pcf
Dry Unit Weight, $\gamma_d$ (pcf)
55
50
45
40
35
0
1
2
3
4
5
6
7
Vertical Pressure, $\sigma_v'$ (psi)
Compost and Sand
Variation of $\gamma_d$ with $\sigma_v'$
Symbol
$w_i$(%)
● 50.7
◆ 27.1
■ 28.1
▲ 52.4

Fig.

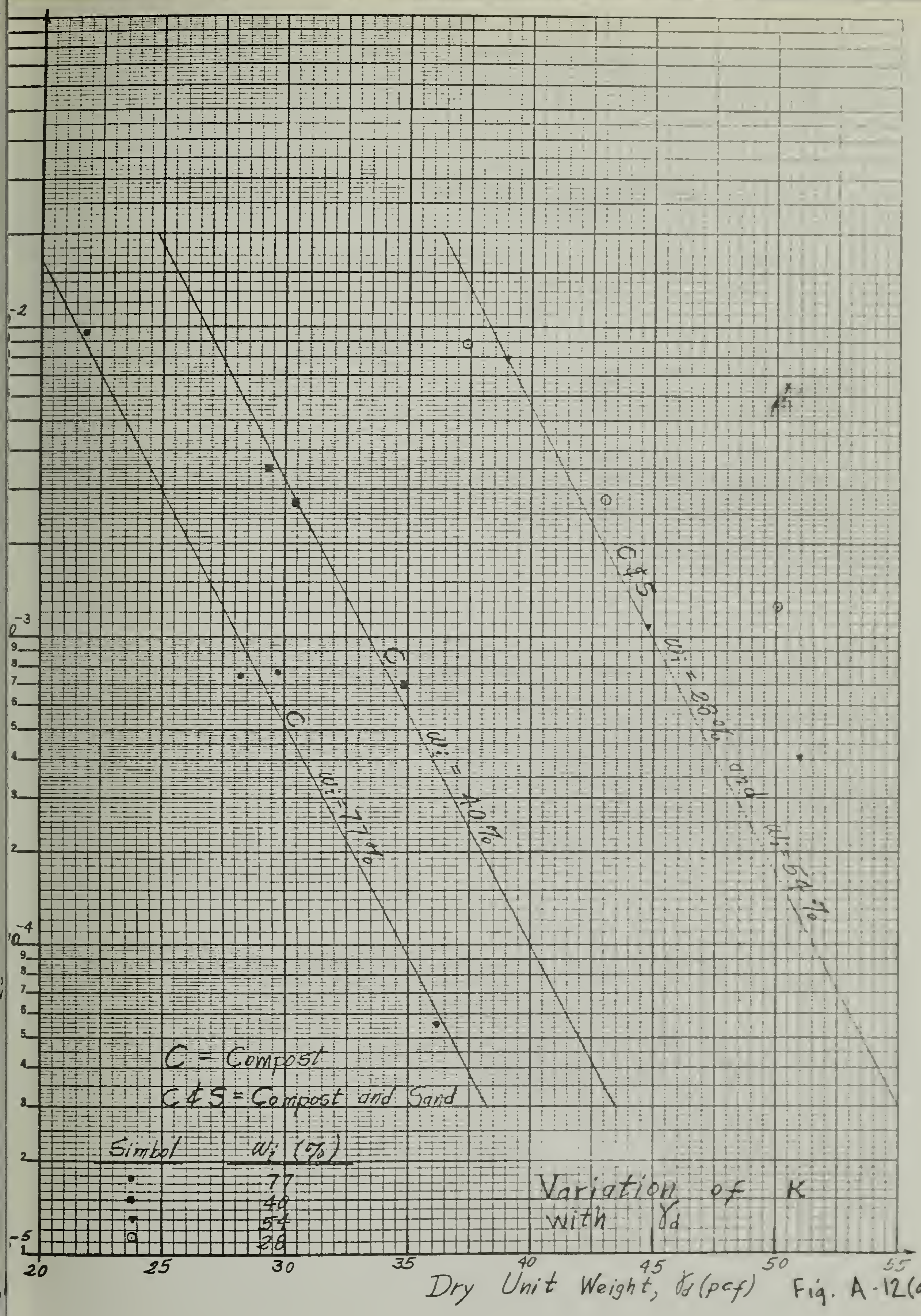

-2
-3
-4
-5
9
8
7
6
5
4
3
2
C
wi = 77 %
C
wi = 40 %
C & S
wi = 28 %
wi = 54 %
C = Compost
C & S = Compost and Sand
Simbol
wi (%)
●
77
■
40
▼
54
⊙
28
Variation of K with γd
20
25
30
35
40
45
50
55
Dry Unit Weight, γd (pcf)

Fig. A-12(a)

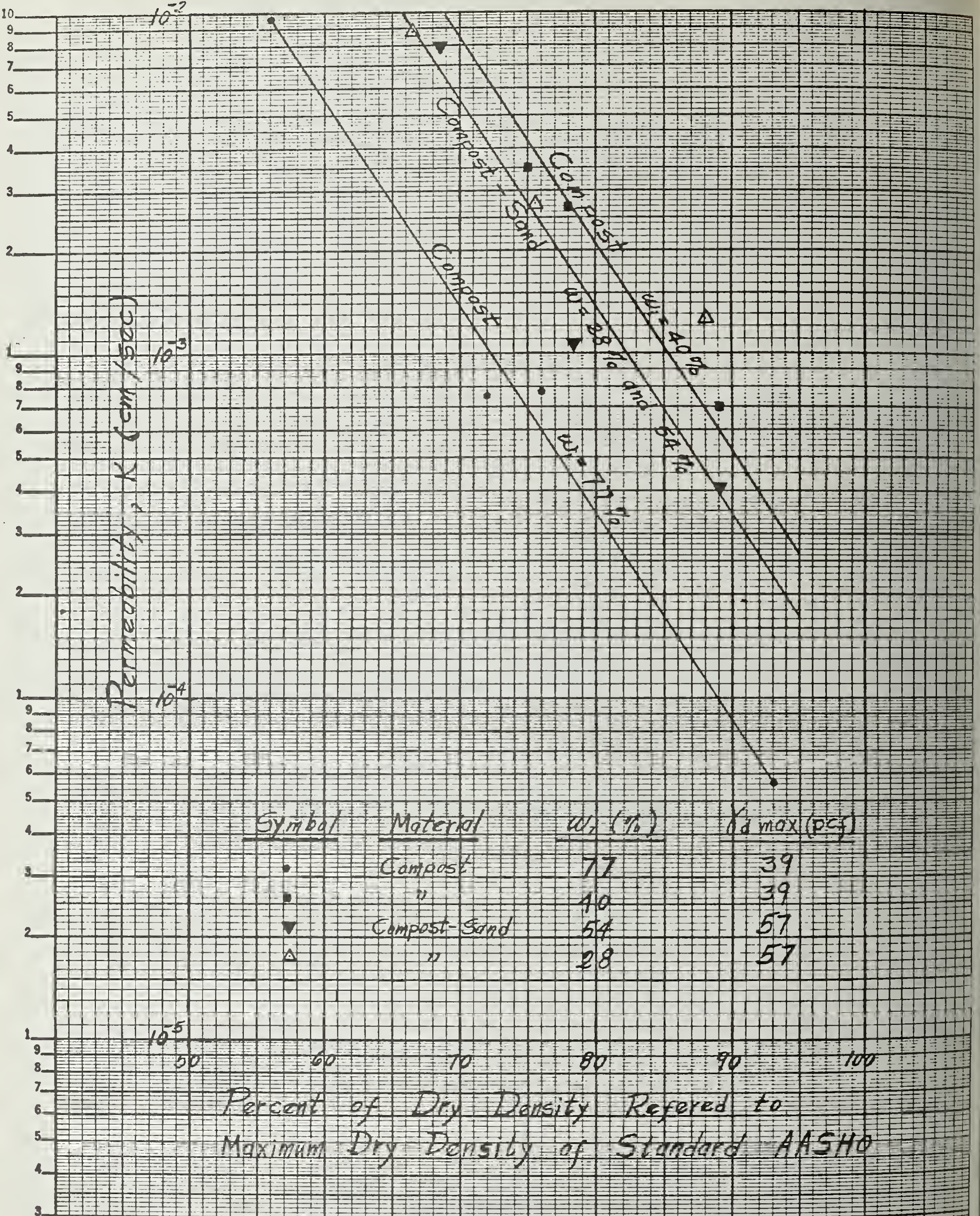


Fig. 12b

Permeability of Compost and
Compost-Sand Mixture

Fig. A-12(b)

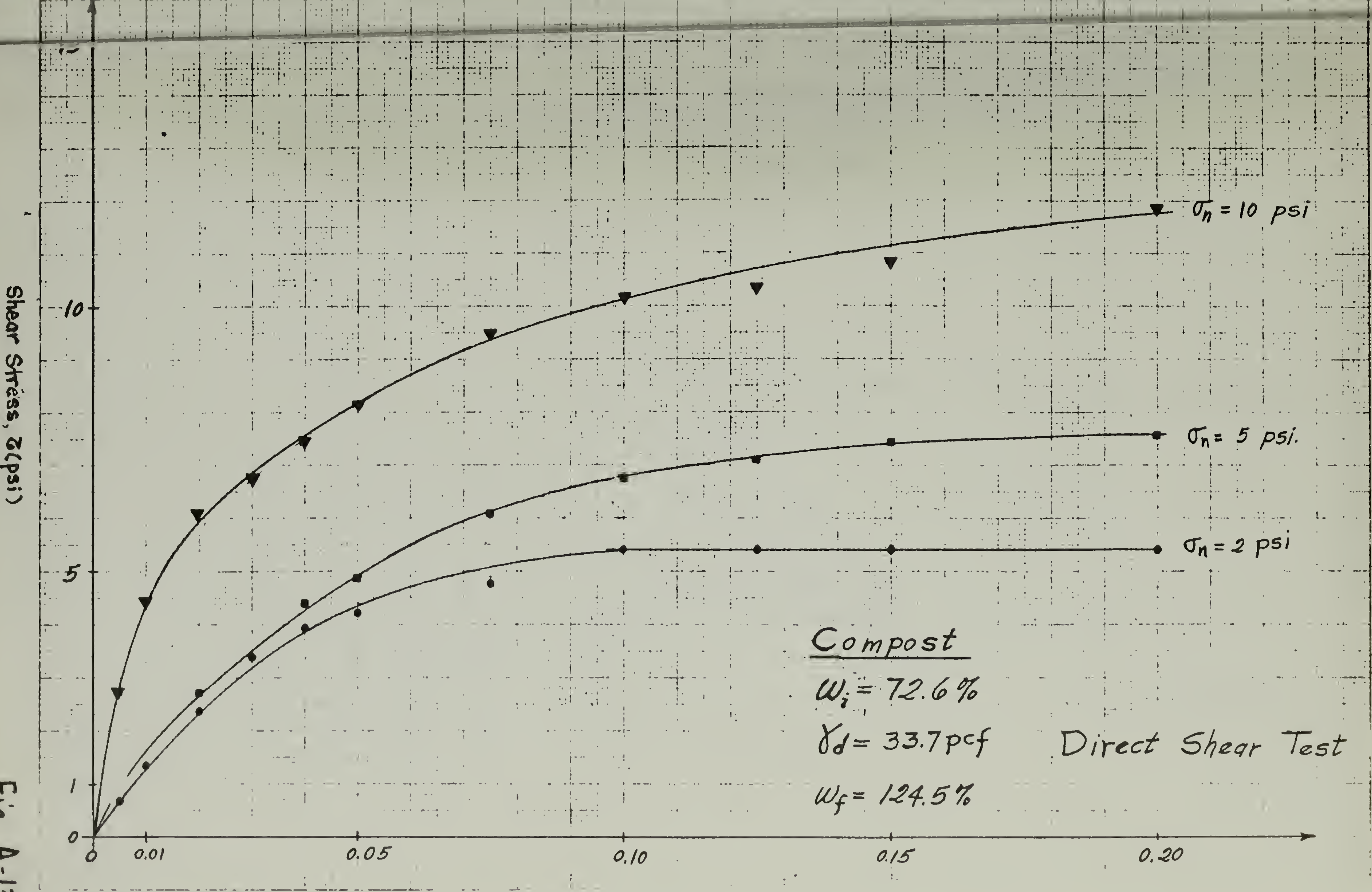

$\sigma_n = 10$ psi
$\sigma_n = 5$ psi.
$\sigma_n = 2$ psi
Compost
$\omega_i = 72.6\%$
$\gamma_d = 33.7$ pcf
$\omega_f = 124.5\%$
Direct Shear Test
Shear Stress, $\tau$(psi)
0
1
5
10
0
0.01
0.05
0.10
0.15
0.20

Fig. A-12

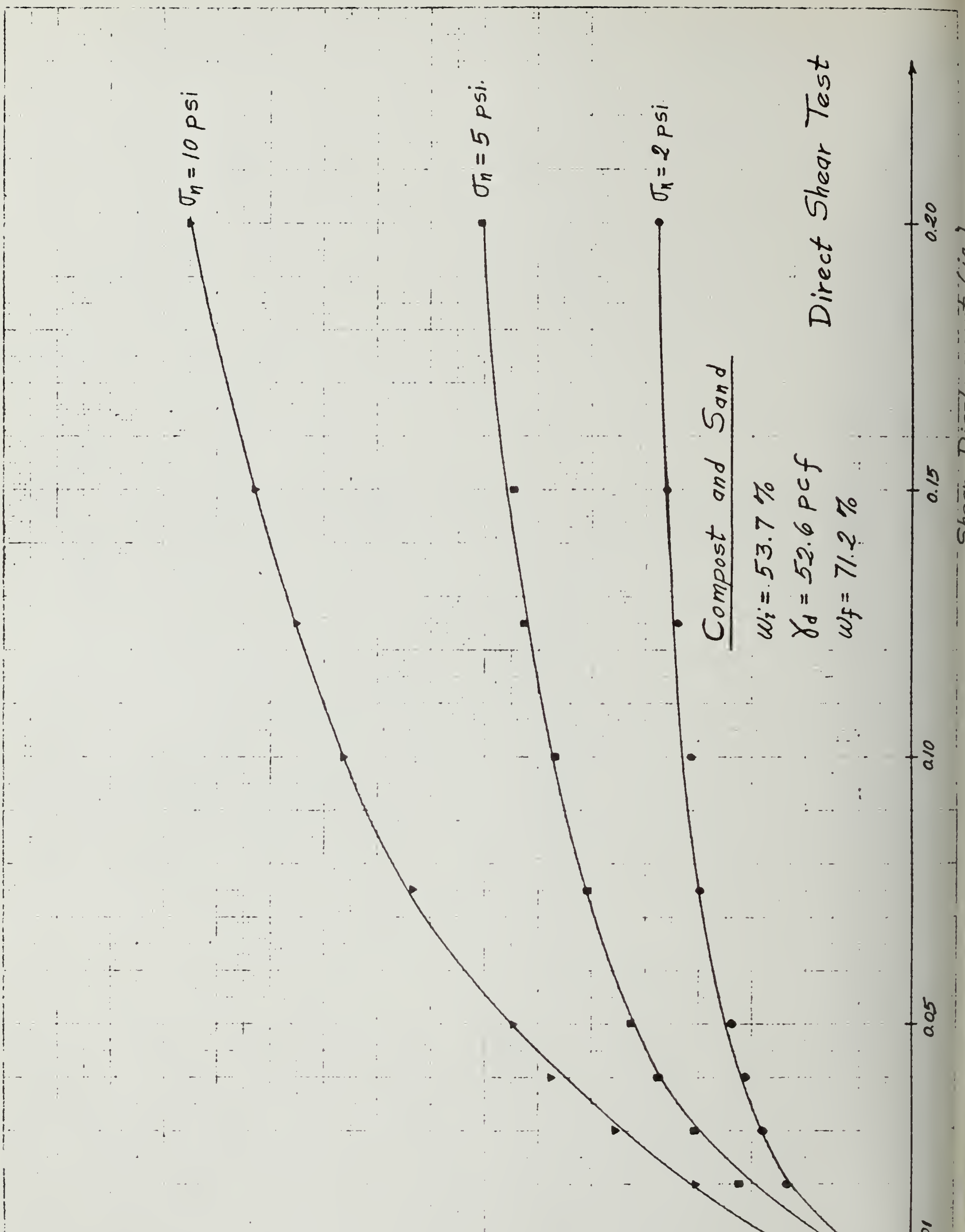
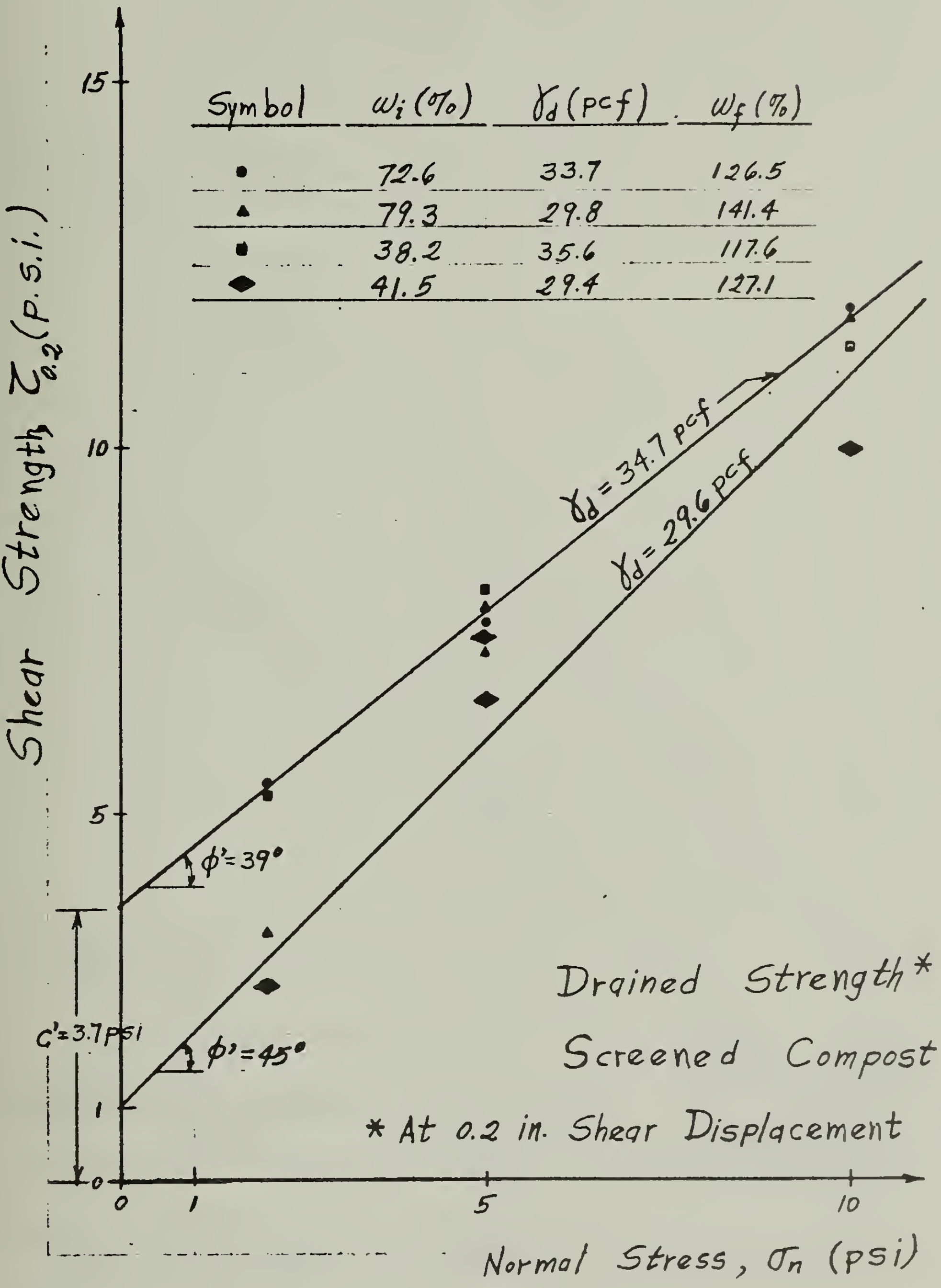

Direct Shear Test
Compost and Sand
$w_i$ = 53.7 %
$\gamma_d$ = 52.6 pcf
$w_f$ = 71.2 %
$\sigma_n$ = 10 psi
$\sigma_n$ = 5 psi.
$\sigma_n$ = 2 psi
Shear Displacement (in.)
0
0.01
0.05
0.10
0.15
0.20
Shear Stress, $\tau$ (psi)
1
5
10
15

Fig. A-14



| Symbol | $\omega_i$ (%) | $\gamma_d$ (pcf) | $\omega_f$ (%) |
|---|---|---|---|
| ● | 72.6 | 33.7 | 126.5 |
| ▲ | 79.3 | 29.8 | 141.4 |
| ■ | 38.2 | 35.6 | 117.6 |
| ◆ | 41.5 | 29.4 | 127.1 |

Drained Strength*

Screened Compost

* At 0.2 in. Shear Displacement

Fig. A-15

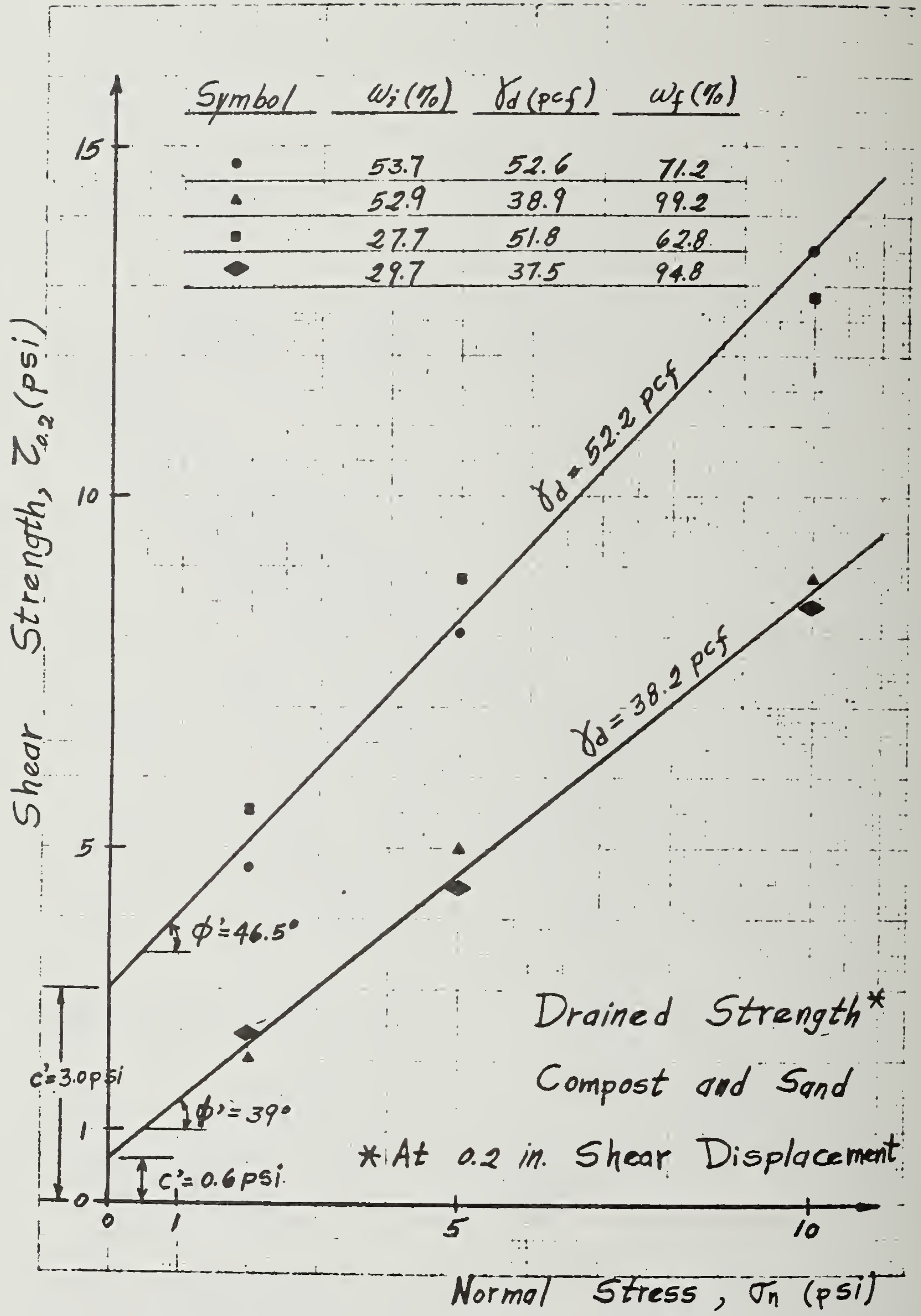
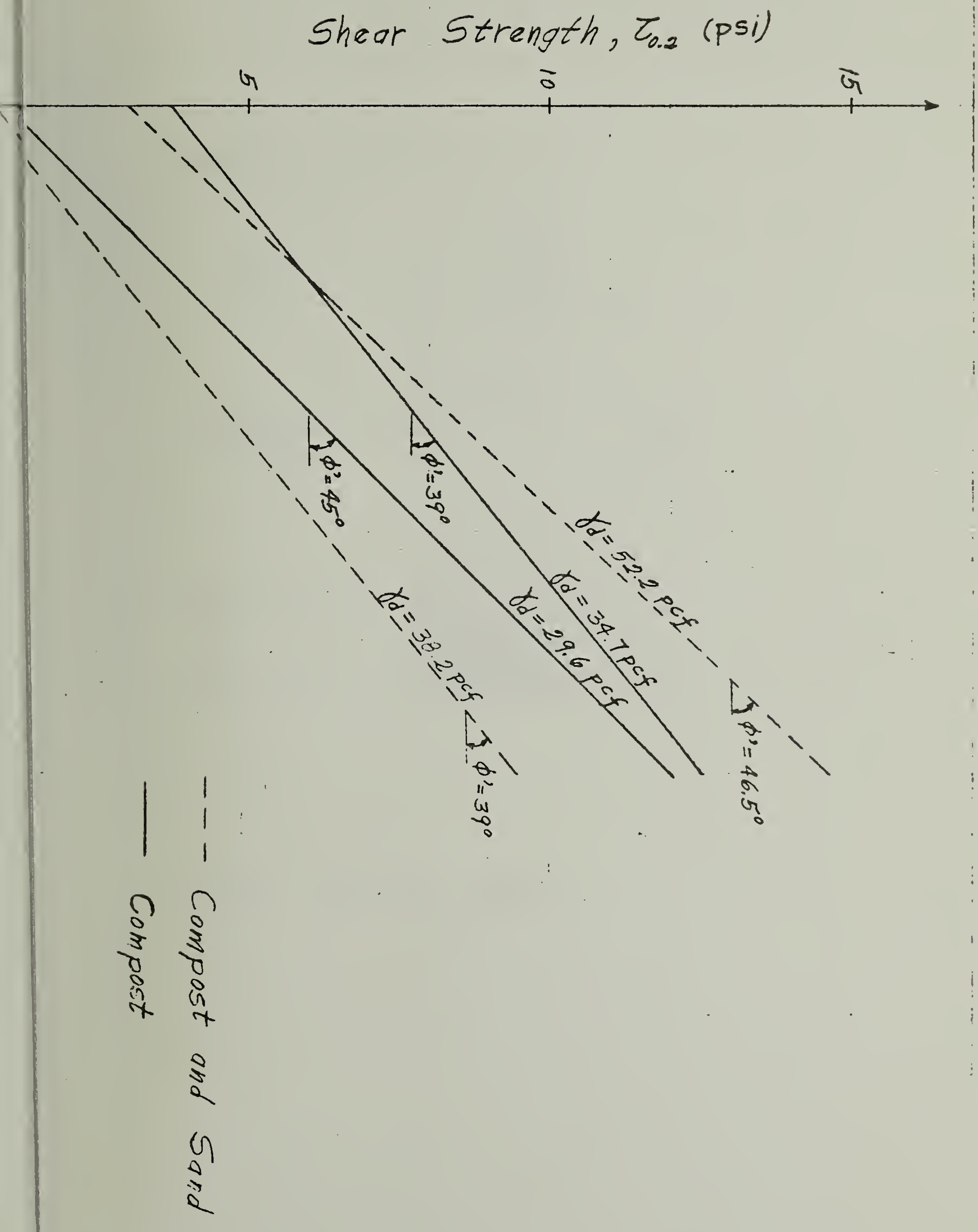
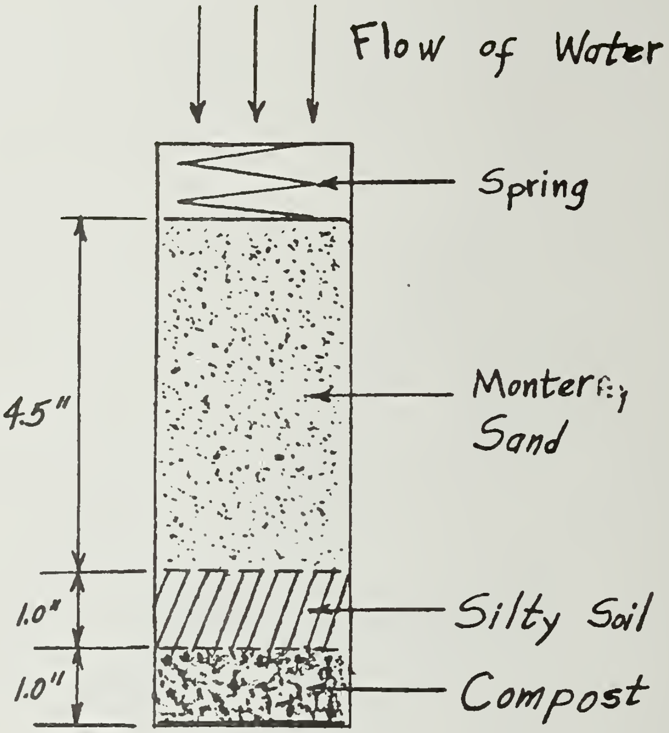

Symbol
$w_i$ (%)
$\gamma_d$ (pcf)
$w_f$ (%)
● 53.7 52.6 71.2
▲ 52.9 38.9 99.2
■ 27.7 51.8 62.8
◆ 29.7 37.5 94.8
$\gamma_d$ = 52.2 pcf
$\gamma_d$ = 38.2 pcf
$\phi'$=46.5°
$\phi'$=39°
c'=3.0psi
c'=0.6psi
Drained Strength*
Compost and Sand
*At 0.2 in. Shear Displacement
Shear Strength, $\tau_{0.2}$ (psi)
Normal Stress, $\sigma_n$ (psi)
0
1
5
10
15
0
1
5
10

Fig. A-16


Shear Strength, $\tau_{0.2}$ (psi)
5
10
15
$\gamma_d$ = 52.2 pcf
$\phi'$ = 46.5°
$\gamma_d$ = 34.7 pcf
$\phi'$ = 39°
$\gamma_d$ = 29.6 pcf
$\phi'$ = 45°
$\gamma_d$ = 38.2 pcf
$\phi'$ = 39°
- - - Compost and Sand
—— Compost



Filter Behavior Test

Fig. A-18

# Appendix B

# Tests on Older Compost

After the tests and analyses described in the report and in Appendix A had been completed, an older compost of municipal waste, prepared at the Metro Composting Plant in Houston, Texas, became available for testing. The material was prepared from shredded municipal waste in a 6-day composting process and had aged outdoors for 1-1/2 years since its production. It is dark brown with soft, fluffy particles which appeared to be more thoroughly decomposed than the younger compost tested previously.

Compaction tests, permeability tests, compression tests, and strength tests were performed on the material, and the results were compared to the results of tests on the younger compost. The results of these tests are shown in Figs. B-1 through B-4.

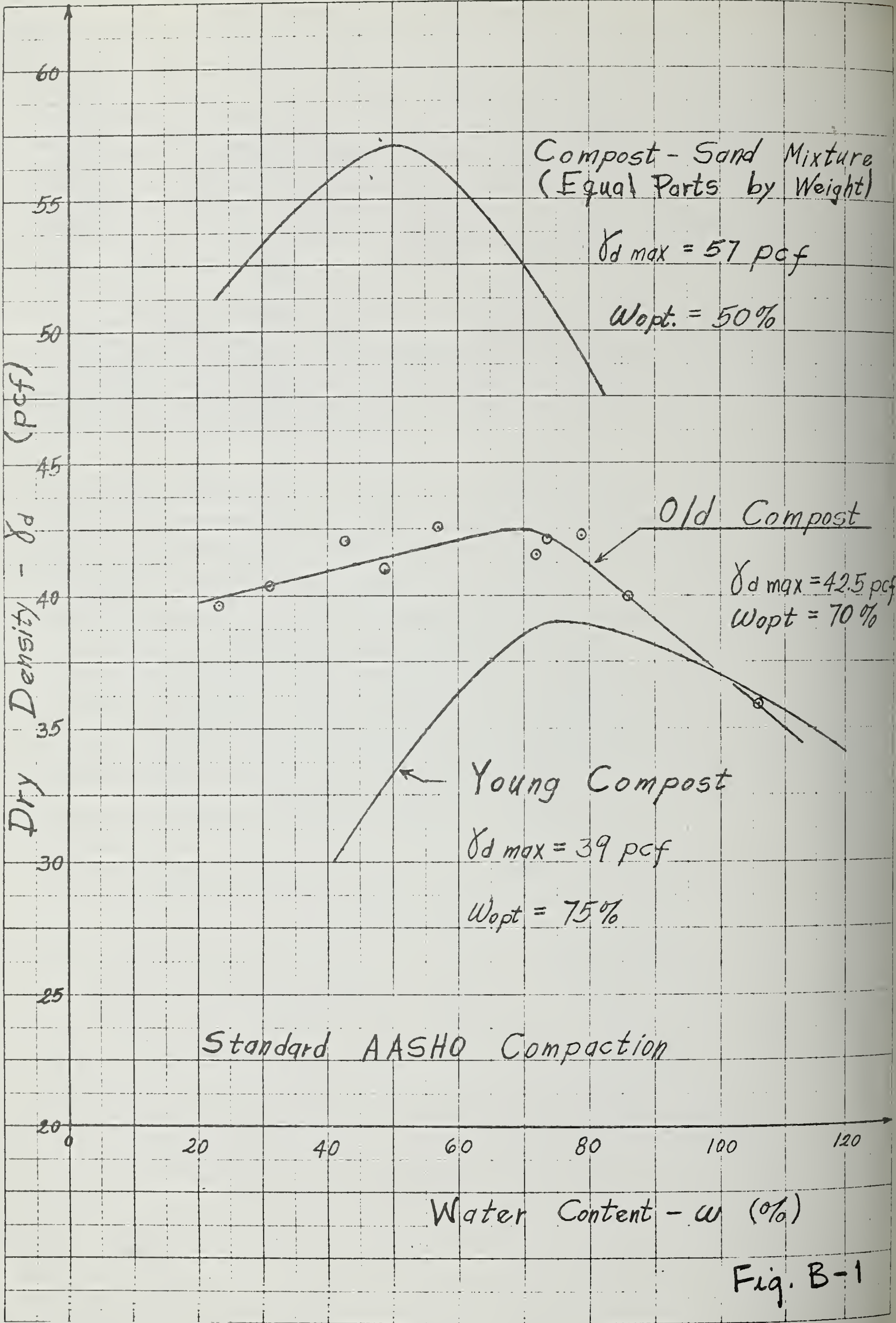
The compaction test results in Fig. B-1 show that the old compost has a slightly higher maximum dry density than the young compost, 42.5 $lb/ft^3$ as compared to 39 $lb/ft^3$. The optimum water content of the older material is slightly lower, however, 70% as compared to 75%. As a result, the corresponding moist density of the old compost is not much different from that of the young compost. At 85% of the maximum dry density and a water content 25% above optimum, the moist density of the old compost would be 70 $lb/ft^3$ as compared to 66 $lb/ft^3$ for the young compost. This 6% greater density would correspond to 6% greater settlement under an equal volume of fill. This difference is probably less than the accuracy of the data and analyses in this report and therefore appears not to be significant.

The permeability test results in Fig. B-2 indicate that the old and the young composts have about the same values of permeability.

The compression test data in Fig. B-3 shows that the compressibility of the specimen of old compost which was tested was less than that of the specimens of young compost. The old compost was compacted to a higher percentage of maximum dry density, however, and this difference in density appears to be the main reason for the difference in compressibility. At equal percentages of the maximum dry densities, the compressibilities of the old and young composts would probably be very nearly the same.

Th strength test results are shown in Fig. B-4. It can be seen that the oler compost is stronger than the young compost, but the difference is prbably the result of higher specimen densities. It appears that specimens of the old compost would have about the same strength as the young compost at equal percentages of maximum density.

On the basis of these tests it can be concluded that the densities, pemeabilities, compressibilities, and strengths of the two compost maerials are very nearly the same. The analyses and conclusions of the man report would therefore appear to apply to the older material as well as the younger.



Compost - Sand Mixture
(Equal Parts by Weight)
$\gamma_d$ max = 57 pcf
Wopt. = 50%
Old Compost
$\gamma_d$ max = 42.5 pcf
Wopt = 70%
Young Compost
$\gamma_d$ max = 39 pcf
Wopt = 75%
Standard AASHO Compaction
Dry Density - $\gamma_d$ (pcf)
60
55
50
45
40
35
30
25
20
0
20
40
60
80
100
120
Water Content - ω (%)

Fig. B-1

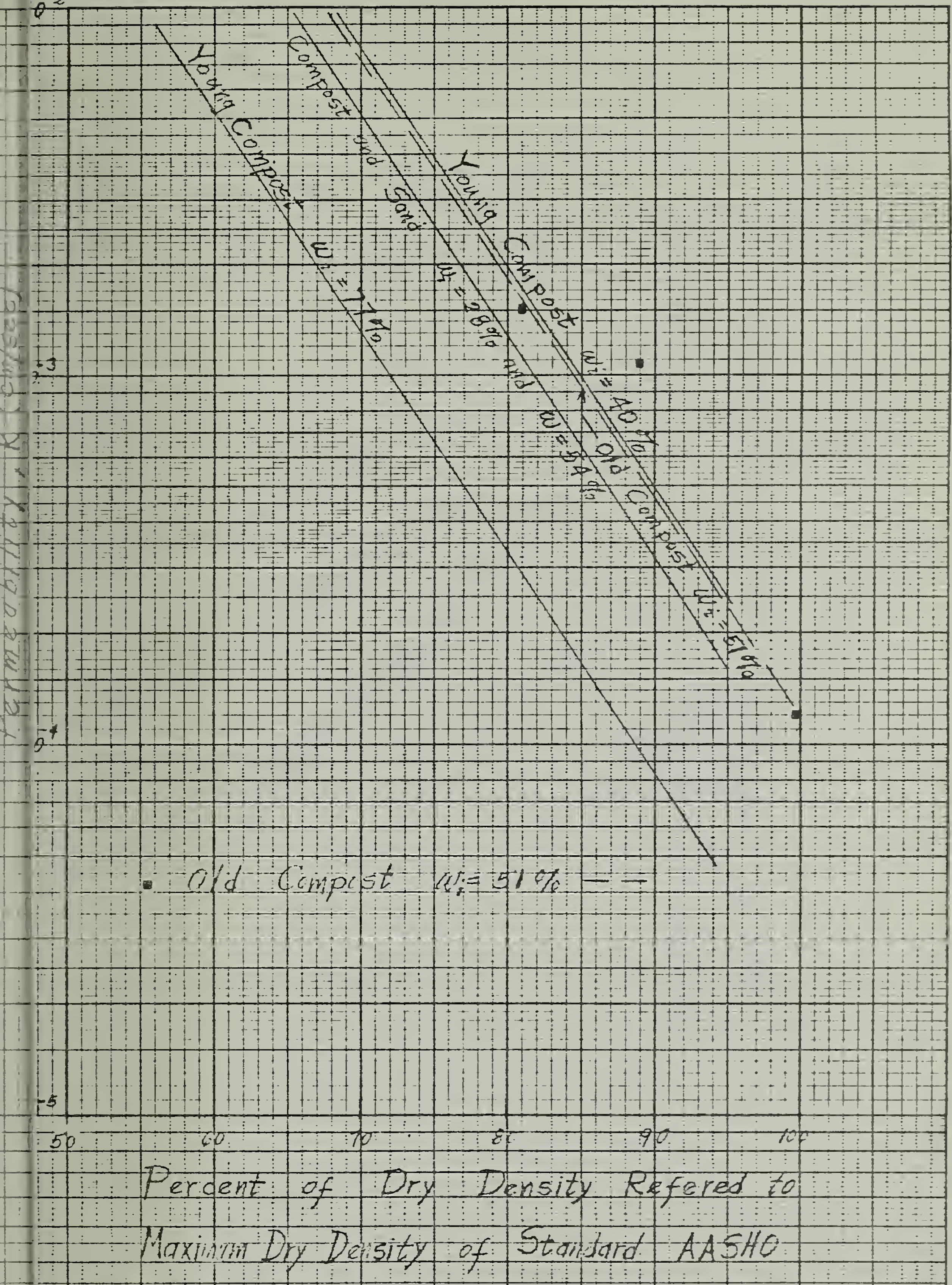
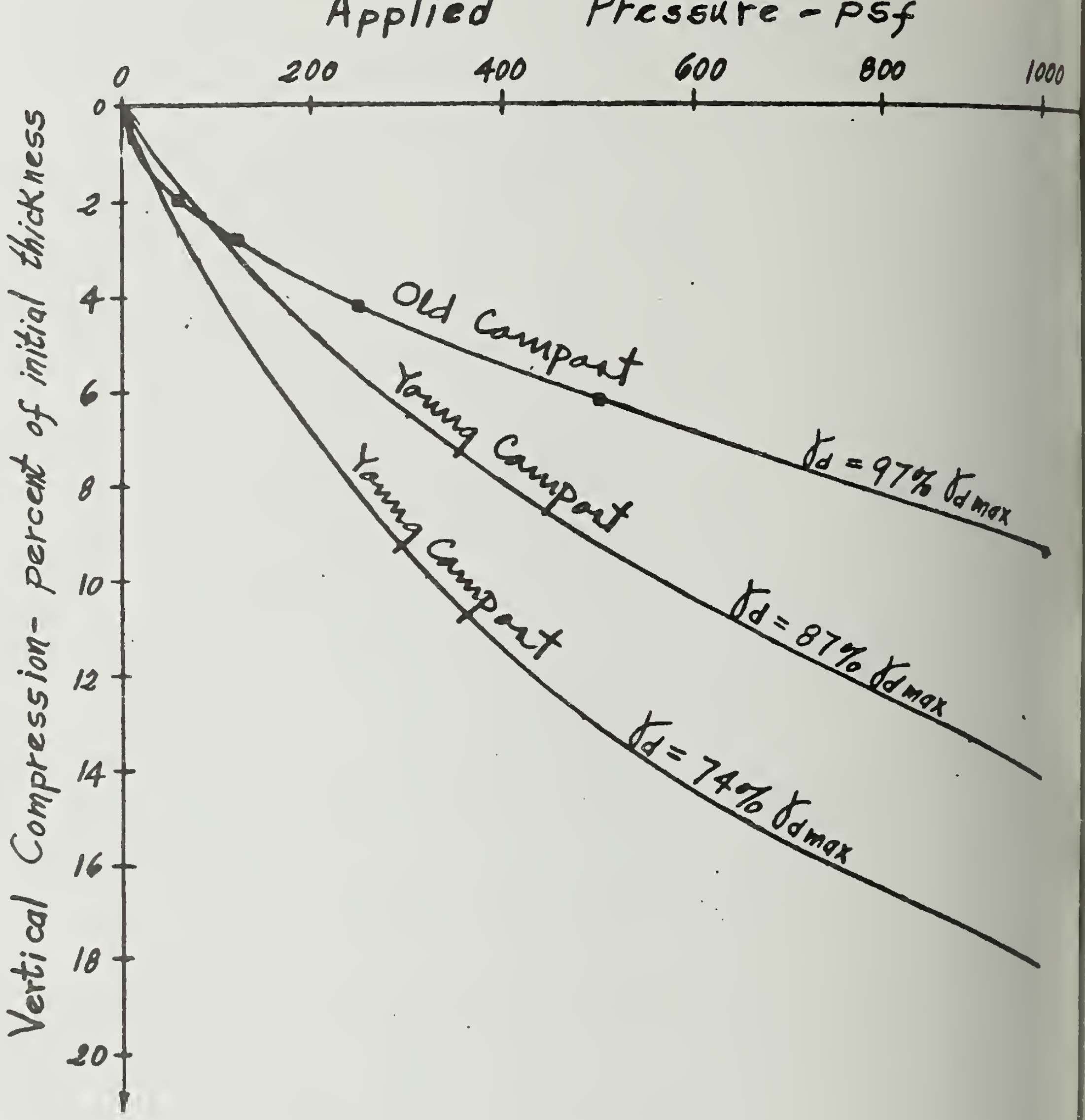
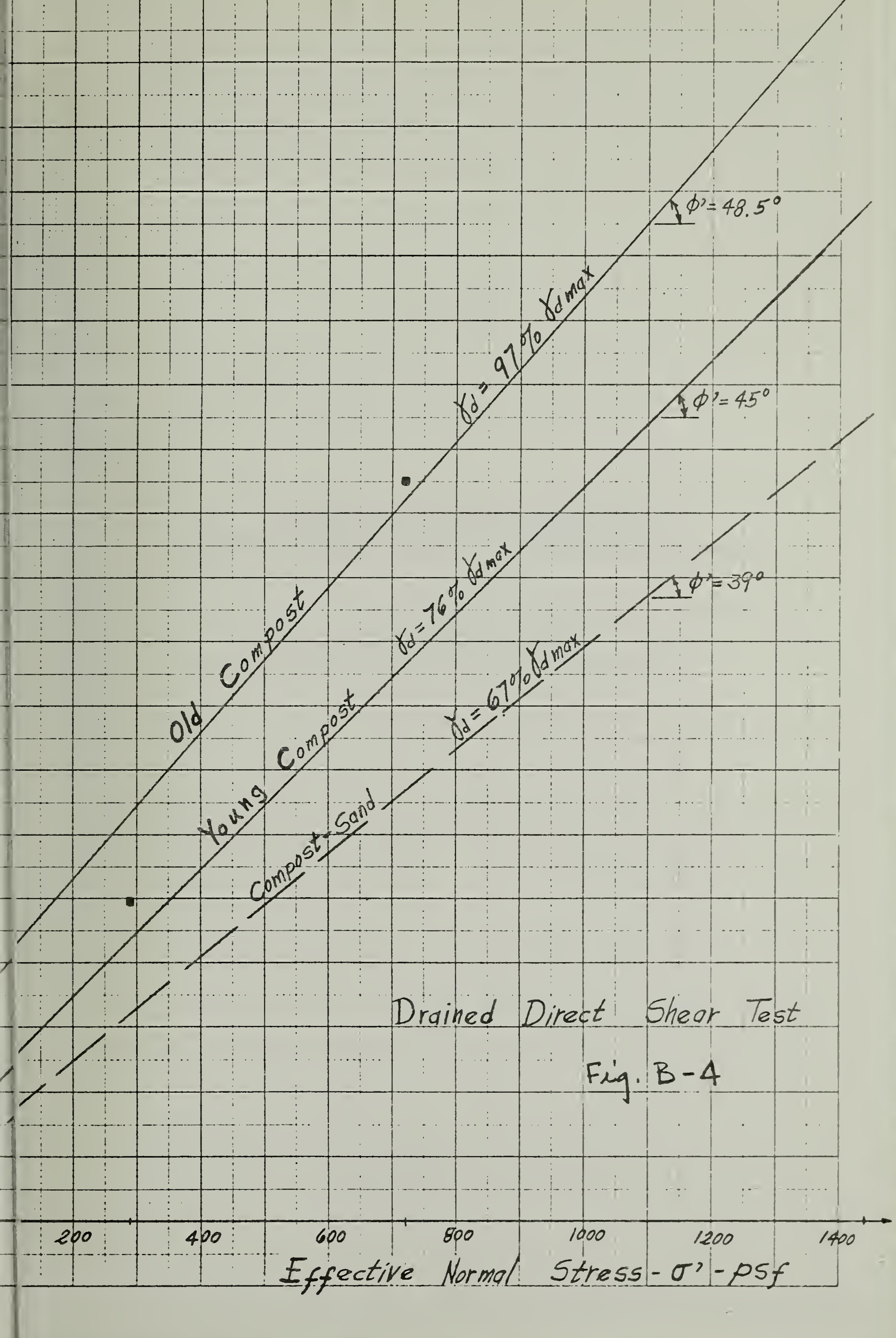

Permeability, K (cm/sec)
0-2
-3
0-4
-5
Young Compost
$w_i$ = 77%
Compost and Sand
$w_i$ = 28% and $w_i$ = 54%
Young Compost
$w_i$ = 40%
Old Compost $w_i$ = 51%
Old Compost $w_i$ = 51% — —
50
60
70
80
90
100
Percent of Dry Density Refered to
Maximum Dry Density of Standard AASHO

Fig. B-2



Compression Curves for Compost, Mixture of Compost-Sand and Old Compost

Fig. B-3



Drained Direct Shear Test

Fig. B-4

# PART B

# A PRELIMINARY COMPOST EXPERIMENT AND SUGGESTIONS FOR COMPOST SPECIFICATIONS

by

S. A. Hart, C.E.
Consultant to EIP Corporation

# THE DAVIS COMPOST EXPERIMENT

## OBJECTIVE

One concept for solid wastes management for the San Francisco Bay Regional Area is to take the refuse and salvage out the glass, ferrous and aluminum cans, and clean newsprint. The putrescible-degradable remainder would be shredded, sewage sludge would be added to it, and "compost" would be made of the mixture. The compost could then be used in the Delta upriver from the San Francisco Bay, as a substitute and supplement to the native peat soils of the Delta islands. The specific use would be for levee-building and for farmland elevation-raising.

There are obviously a number of questions that need to be answered before such a procedure can become a reality. Typical of such questions are:

a. How beneficial would the compost be to the Delta area?

b. What might be the best way to make the compost?

c. Where should the compost be made?

d. What are the materials handling problems year-around, and what are the additional problems in winter?

e. What are the nuisance problems in compost-making?

f. How best might the nuisance problems be overcome?

g. What will the pollution problems be, especially regarding nitrates in the Delta waters?

h. What kind of costs are likely?

Definitive answers to these questions can only be obtained from a pilot-scale demonstration project of perhaps 500 to 1,000 tons of shredded waste per week. However, a better understanding of the above questions, and some direction for pursuing the pilot-scale demonstration, can be obtained from preliminary experimentation. Thus the objective of this present research is to better understand the above questions, and to obtain direction for designing, developing, and promoting the pilot-scale demonstration, so that the final and definitive answers to the questions themselves can be economically and satisfactorily obtained.

## WHAT IS COMPOST AND COMPOSTING?

Composting is defined as the sanitary bio-stabilization of organic waste. (Ref. H. B. Gotaas, "Composting", World Health Organization Nomograph No. 31, 1956.) Composting can occur aerobically or anaerobically. Anaerobic stabilization is typically a slow-rate process taking one or more years, and disagreeable odors can occur during the process. Aerobic composting is minimally odor-producing (and the odors that do occur come primarily from anaerobic pockets within the aerobic mass), and it can be quite prompt--a matter of days or weeks depending upon the mechanical assist and the maintenance of optimum conditions.

In essence, microorganisms use the refuse material as a food supply; the microorganisms eat away, grow, reproduce, and cast off lower-energy or more stabilized organic detritus. In aerobic composting, the aggressive metabolic activity results in heat generation, consumption of oxygen, and respiration of carbon dioxide. A typical active aerobic composting mass may develop temperatures in the 50's and 60's, °C. When the readily available "food supply" is consumed, the organic material changes characteristic and composition, and the end product is called "compost." Today at the nursery store, one can buy the end product of bio-stabilization of specific wastes--such as redwood compost, leafmold, and composted steer manure. Compost made from municipal refuse is a very similar product if the non-compostable debris is removed from the finished material.

Considerable scientific investigation has been conducted into the biochemistry of the composting process, including chemical analysis of the raw material and the finished product. Fortunately, much of the involved science can be reduced to an analysis of the carbon: nitrogen ratio. This does not mean that one can make compost from carbon or soot in the chimney and nitrogen in the atmosphere; rather, the carbon in carbohydrates and the nitrogen in fertilizers, amino acids, and protein are the critical components of a compostable material. A typical compostable raw material may have a C:N ratio of 100:1. If moisture, oxygen, and microbial population are correct, this material will compost. In composting, much of the carbohydrate is broken down to carbon dioxide and leaves as a gas; the resultant stabilized "compost" will have a C:N ratio of 20:1 to 40:1.

In measuring the progress of composting, temperature, C:N ratio, moisture content, the composition of the gas or atmosphere of the pile, and the general appearance of the organic mass are used to evaluate the process. In the experiment reported here, a comprehensive program of measurement was not possible, but trends and indications of the above factors were obtained.

## THE EXPERIMENTAL SETUP

Professor C. C. Delwiche, Department of Soils and Plant Nutrition, University of California at Davis, was contacted by the EIP Corporation regarding conduct of some preliminary experimentation. Dr. Delwiche has been the University's leading advocate of Delta island peatland preservation, and independently conceived of utilizing municipal compost for reclamation of the islands. Dr. Delwiche was not in a position to conduct the entire preliminary experiment, but agreed to be involved in it, and to have it done at the University of California campus at Davis, if the physical conduct would be done by others.

Samuel A. Hart, C. E., is a consulting engineer who has been involved in composting research, compost utilization, and economic appraisals of the process for over a decade. Dr. Hart was retained by EIP to conduct the composting experimentation, and to manage the engineering aspects of the project.

The experiment basically consisted of hauling 30 cubic yards of shredded, classified and cleaned-up municipal refuse from an EPA-sponsored facility in Palo Alto to the Davis campus of the University of California.

This dry, shredded, refuse was wetted with digested sewage sludge liquor as it was forked off the hauling truck. The resultant pile or "windrow" was allowed to compost--to bio-oxidize and biologically stabilize until it became finished "compost". The specific approaches to assisting the material to progress into compost are discussed below.

## A CHRONOLOGICAL AND NARRATIVE COMMENTARY OF THE EXPERIMENT

This first experimentation had to be something of a "cut and try" approach. A chronological description and discussion of what was done and why seems to be the best way to cover the May 1973 activity.

On Wednesday, April 25th, an industrial waste collection truck went to Palo Alto and picked up a load of shredded municipal waste that had the iron, glass, and aluminum removed from it. This was typical municipal waste, and was predominately paper, but contained considerable plastic film, and some cloth, hard plastic, and food scraps. A full 30 cubic yards of material was loaded on at Palo Alto, but the trip to Davis consolidated the waste so that the volume when it arrived at Davis was only 27.8 cubic yards. The weight of the waste was 9690 lbs; based on the original 30 cubic yards, the material weighed 323 $lb/yd^3$ (11.96 $lb/ft^3$.)

On Saturday, April 28th, five teen-agers were hired to pitchfork the refuse off the truck and mix it with sewage sludge. The sewage sludge was provided by the University of California from its on-campus treatment plant. 3700 gallons of digested sludge were squirted onto the refuse during unloading, as shown in the photos.

Although a sample of the sludge was taken to the laboratory for analysis, its exact solids content was omitted. It was estimated to be 6% solids. The below tabulation suggests the resulting mixture.

| Material | $\%H_2O$ | Total Wt. | Solids Wt. | $H_2O$ Wt. |
|---|---|---|---|---|
| Refuse | 15.8 | 9690 | 8160 | 1529 |
| Sludge | 94.0 | 30895 | 1855 | 29040 |
| Mixture | | 40585 | | 30569=75.3% $H_2O$ |

In actual fact, two samples of the mixture immediately after making the windrow measured 46.9 and 51.3% $H_2O$. Considerable moisture from the wetting of the refuse was absorbed by the underlying earth. And from visual inspection after completion, it was felt that too much sludge liquor had been added. One could squeeze moisture out of a handful of the mixture.

A second materials balance was taken on the refuse and sludge--a Carbon:Nitrogen analysis. Using the above weights and C:N data, the following tabulation is presented.

| Material | Total Wt. | Carbon Wt. | Nitrogen Wt. | C:N Ratio |
|---|---|---|---|---|
| Dry Refuse | 8160 | 3810 | 29.5 | 129 : 1 |
| Sludge solids | 1855 | 1000 est. | 92.8 | 10.7: 1 |
| Mixture | 10015 | 4810 | 122.3 | 39 : 1 |

The C:N ratio of two mixed samples averaged 66:1, thus the calculated data does not agree too well with the analytic. Regrettably, in this preliminary experiment, there were not enough dollars available to obtain the laboratory control that would have been desirable.

The week of April 30-May 4 was the first week of actual composting, and the windrow needed to be turned. An attempt was made to do it with hoe and pitchfork. This was completely impossible. The mixture was so wet it almost had the consistency of wet paper-maiche. Only about 10% of the pile was turned in 12 man-hours of work. Therefore, on May 7th, the University's backhoe was used to turn the remaining 90% of the pile. This was very effective in moving the windrow, but

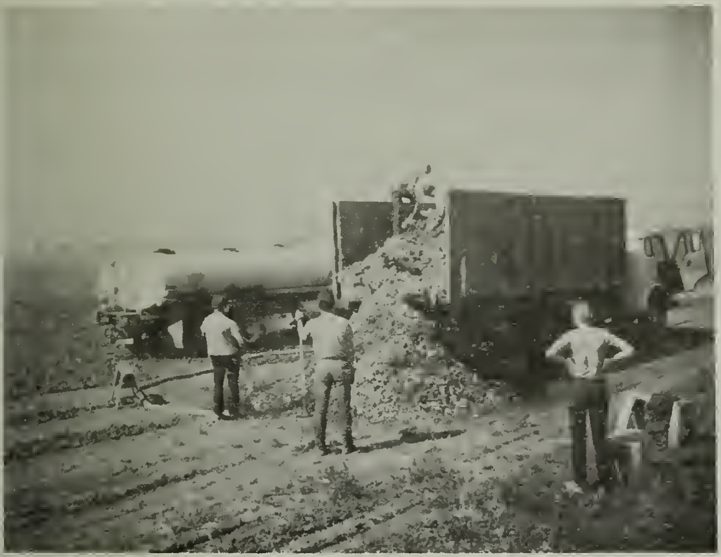


Fig. 1    Refuse unloading with sludge tanker in background

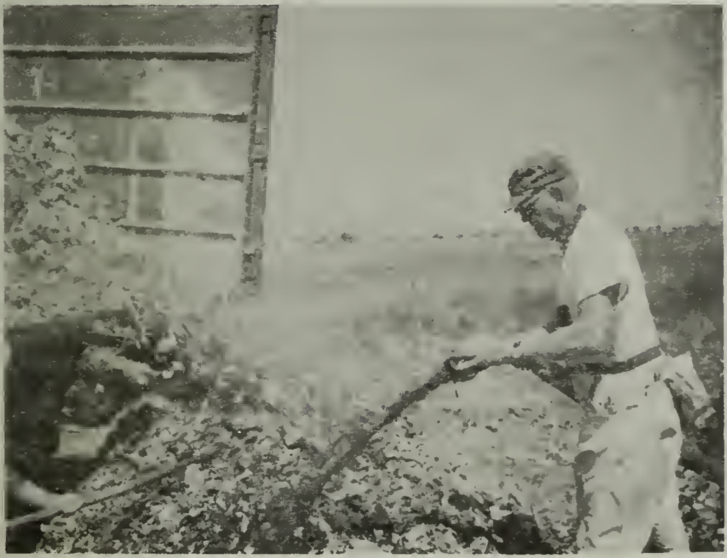


Fig. 2    Applying the sludge to the refuse.

complete mixing and aeration was not obtained. However, this intitial breaking up of the pile helped very much, and made subsequent manipulation much more satisfactory.

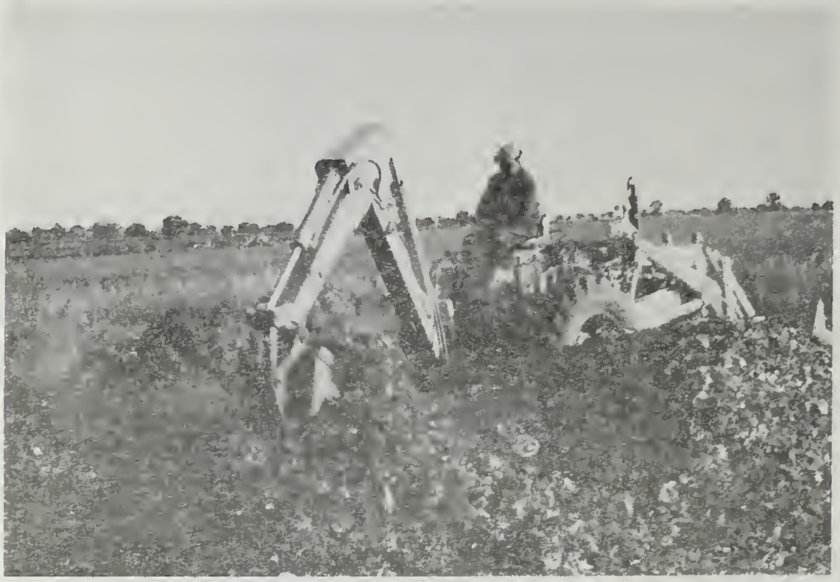


Fig. 3 Use of the Backhoe to make the first turning.

Odors during the first week were more typical of digested sewage sludge than anything else. There was an odor in the vicinity of the windrow, but it was not overly objectionable or powerful, and was not evident 100' from the pile. When the pile was being turned--by hand and by backhoe--a reasonably strong anaerobic and disagreeable odor emanated. After a few minutes near the pile the odor lost its noticeableness, but it clung to one's clothes and was noticed by others away from the experiment.

It was obvious that too much moisture had been added to the refuse in the original sludge mixing, in spite of the fact that the C:N ratio was still high (66:1 after mixing). It would appear that at least a partial dewatering of the sludge would be desirable prior

o mixing it with the milled refuse--if composting is the prime
bjective. However, when disposal of the wastes is recognized as
he prime objective, the balance between sludge and refuse can be
econdary to the disposal of the two quantities of waste.

lthough the wetted refuse retained the sludge liquor well, some
rainage did occur. This saturated the underlying native earth,
nd made for difficulty in making the first turning. Additionally,
t is certain that this would create odor and fly breeding problems
nder some circumstances. Therefore, it also appear desirable that
ny windrow composting be done on a concrete or asphalt slab. It
s noteworthy that such a finding was learned on this initial exper-
nentation, and serves to guide the planning and design of the pilot-
cale demonstration proposal.

ne week of May 14 - 18 was the second week of composting. The
urning difficulty in this experiment can be translated into costs
nd technical problems when large quantities of waste are to be
omposted on a daily basis. Therefore, a decision was made to
nvestigate a second approach to composting, with a part of the
olume of the experimental waste. Specifically, it was conceived
hat shredded refuse plus its mixed sludge could be laid down in
1' or 2' thick blanket, and be covered with a 3-4" sheet or top
ressing of finished, high-grade, screened compost for appearances
ake. If this blanket and top dressing were kept moist, it would
emain aerobic and compost itself over a period of 4 to 6 months,
he result being "in situ composting". At the end of six months,
freshlayer of shredded refuse and sludge, covered with yet
nother top dressing of high-grade screened compost could be
laced over the first layer, and it too would compost. This layer-
ng of refuse that would change to compost could be done on the
evee banks, or in the Delta island interior. Over a period of
everal years, a significant volume of waste material would be
roperly managed, the composting would proceed with efficiency and
onomy, and the resultant land or levee would be benefitted equally
conducting the composting in another manner.

test this concept, approximately half the original windrow was
laced in 6½' diameter rings, as shown in Fig. 4.

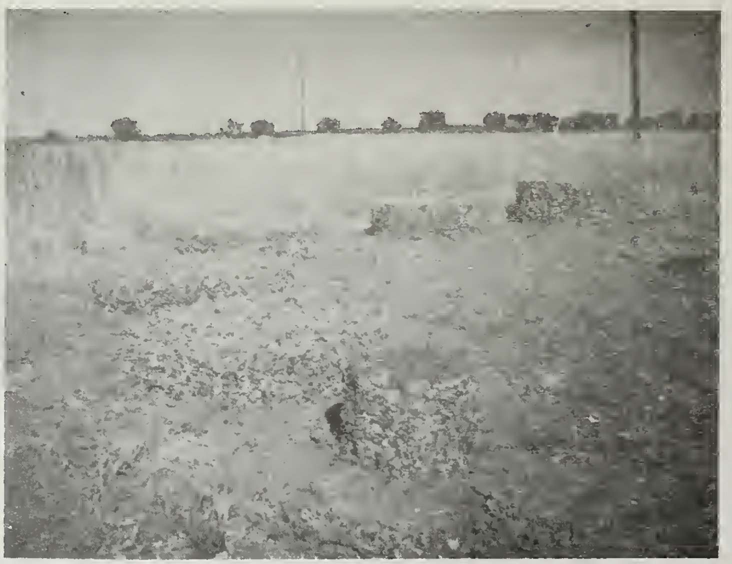


Fig. 4. Rings of composting waste for in situ bio-stabiliazation

The specific layout of the rings is:

1' thick, a loose blanket
1' thick, compacted to simulate consolidation from traffic
2' thick, loose blanket
2' thick, consolidated
3' thick, loose

Because no high-grade screened compost was available as a top dressing, these rings were left uncovered. However, a small ring was covered with some locally available leafmold, Fig. 5.

Fig. 5. Model of in situ composting, with leafmold top dressing

As a final comment to this second turning activity, it was noted that this second turning could be done very satisfactorily with a hoe and pitchfork. This was in marked contrast to the problem of the first turning.

The week of May 21-25 saw the residual pile turned for the third time. This third turning was also easily accomplished by hand. The odor level in making the second turning was less than in the first turning, but was still evident and rather disagreeable. The odor of the third turning was quite minimal, and although not truly pleasant, was not considered disagreeable.

The two turnings of the ringed waste, and the three turnings of the remainder, plus the biological degradation that has already taken place, has effected a considerable reduction in volume. Of the original 30 cubic yards of refuse brought to the campus, the volumes at the end of the week were:

1' loose ring, sunk to 11" high = 1.15 cu yards
1' compacted ring, sunk to 11½" = 1.21
2' loose ring, now 20" high = 2.11
2' compact ring, now 22" = 2.32
3' loose ring, now 28" = 2.96
Residual pile, approx. volume 13.33
Total 23.08 cu yards

This is a reduction of 23% in volume to date.

The week of May 28-June 1. It appeared that the rings and pile were becoming quite dry. Specific moisture content determinations were not easily made, but a part of the "cut and try" experimentation included the need to maintain moisture, and to appraise the possibility of sprinkler irrigation of the blanket or the windrow. A wetting of the rings and pile was therefore made. The data on this, plus the temperature data on the rings and pile is tabulated below.

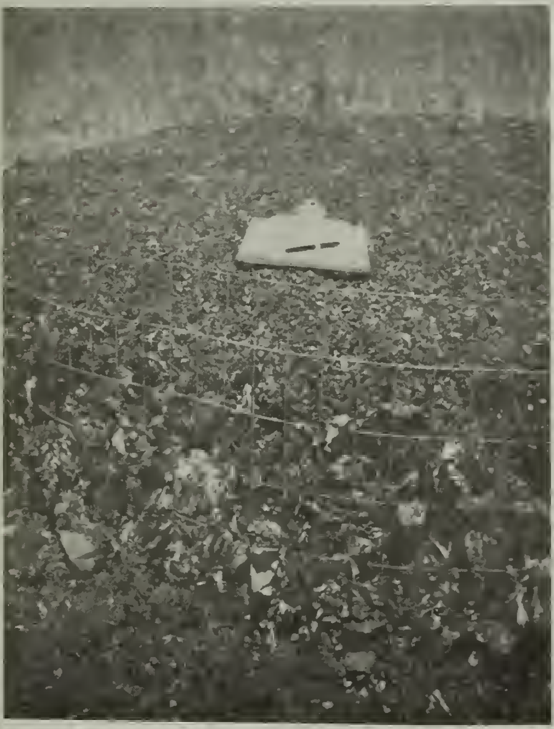
Temperature and Irrigation Data

| Unit | May 3 | May 10 | May 17 | May 24 | May 31 | Total $H_2O$ | Inches per foot |
|---|---|---|---|---|---|---|---|
| Windrow | 38°C | 48 | 45 | 64 | 65 | 3.4" | 1.4 |
| 1' loose | - | - | 50 | 45 | 40 | 2.4 | 2.4 |
| 1'compact | - | - | 41 | 48 | 47 | 3.4 | 3.4 |
| 2' loose | - | - | 64 | 46 | 60 | 11.6 | 5.8 |
| 2' compact | - | - | 54 | 55 | 59 | 6.0 | 3.0 |
| 3' loose | - | - | 60 | 55 | 57 | 5.3 | 1.7 |

In retrospect, the irrigation was perhaps not as warranted as originally thought. It would have been more desirable to have purchased some redwood bark compost to cover the tops of the rings to prevent their drying out, then to merely have watered them lightly. On the other hand, the turned windrow is drying out excessively from the turnings, and it really does have to be kept moistened or else much of it is becoming so dry that it will not continue to compost. However, the irrigation was useful in that it showed the absorbtion capacity of the composting material is tremendous. Nor does the irrigation make the loosely-packed rings consolidate further or faster. Thus it can be conjectured that winter rains will have no detrimental effect on a blanket of in situ composting material.

## SECOND MONTH'S ACTIVITY

During June 1973, the actively-turned pile received its 4th and 5th turnings. A shredding-screening test was made on a portion of the 4th-turned compost. Approximately 50% by weight, about 33% by volume, of the material went throught the 3/4" shaker screen of the soil shredder. This machine has a hammer mill prior to the screen, and considerable of the plastic film was torn into small enough fragments to go through the screen. However, the screened material still looked quite good. It was not truly finished compost, in that when put into a container, it slightly reheated. The shredded material was quite brown, light in weight, and friable with a faint soil-like odor. Some of the material was used to cover the top of the ring of in-situ composting material. It is shown below.



Quality of the shredded and screened compost

Some of the material was taken to San Francisco where EIP will have tests made on the structural strength of the material.

The plastic film problem deserves special mention. Plastic film was not at all obvious in the original shredded, air-classified, dry refuse. When the sewage sludge was added to the refuse, the paper absorbed the moisture, which the plastic film did not. The film thus became more visually evident. As composting has progressed, the film has become ever more evident. Probably the film amounted to only 1-2% of the original refuse by weight and volume, and today it is still a minimal component by weight and also by volume. However, the "surface area presentation" is extremely evident. The screening operation (preceeded by the shredding of the hammer mill) does tear some of the plastic so that a bit of it goes through the screen, but in reality, the screened compost does look good. The scalpings from the screening contained a significant amount of plastic, and although this was repiled for composting and is reheating, the plastic film will still have to be handled at a later date. It is thus apparent that the plastic film problem will require specific resolution over the long-term.

One possibility is to do the compost screening at the completion of composting--after 6 to 8 turnings and several months. The scalpings should then be primarily plastic film, refractory material, and contain a minimal amount of water-containing organic matter. These scalpings could well have a high heat value and be incinerated. Alternatively, the scalpings could be buried beneath the high-quality compost. This latter is a viable solution if in-situ composting should be considered. In any event, plastic film becomes ever more evident as stabilization reduces the presence of the paper, garbage, and other biodegradable components of the refuse.

Paper blowing is a second problem that should be commented upon. The original wetting of the refuse was effective in weighting down the paper component so that blowing was not a problem during the first stages of composting. Even today, paper itself is not serious, but as the paper biodegrades, it leaves the plastic film. During turning of the material, the film now tends to blow badly. It has been necessary to move out to the adjacent fields to retrieve that film. It is absolutely evident that a structure will be necessary in which to do mechanical turning of the compost.

## THIRD MONTH'S PHYSICAL ACTIVITY

The turned compost pile received its 6th turning during July. It had been intended to also do a 7th and final turning, but there was no time to do it, so this will wait until later. All rings and the turned pile were irrigated twice. Temperatures have been taken, and there continues to be significant biological activity in all piles and rings, with temperatures generally in the 38-44°C range (around 100°F). However, the 1' and 2' compact rings run 3 or more degrees hotter than their loosely-placed counterparts. This, plus the general observation that the compact-placement rings accept the irrigation water better (without wet and dry spots and without premature leakage), and with an intangible but apparent better appearance of the composting mass indicate that in-situ composting occurs better if the waste is placed in a somewhat compact condition.

Bulk density testing had been attempted in May and June, but the results were erratic and unreliable. The technique was refined through two additional test in July, and reasonably reproducable results were obtained. There results are:

Bulk Density in lbs dry solids/$ft^3$

| Sample | July 2 test | July 18 test |
|---|---|---|
| 1' loose | 7.1 | 10.0 |
| 1' compact | 13.7 | 14.8 |
| 2' loose | 7.9 | 9.4 |
| 2' compact | 16.0 | 16.3 |
| 3' loose | 11.4 | 10.6 |
| Main Pile | 10.6 | 12.9 |

It is thus realistic to believe that the composted dry solids, when placed, will average someplace between 12 and 15 lb/$ft^3$.

And finally, using the bulk density data and the known volume of the rings and pile, a calculation was made on the loss of organic material due to composting. Specifically, between 30 and 35% of the original dry solids weight of the refuse and sludge has been lost due to biological attack, conversion, and stabilization.

## AN IMPORTANT COMMENTARY OR DISCUSSION POINT

During July, Alan Carlton, a consultant to EIP, visited the experiment. His knowledge of Delta agriculture brought out a point that has not previously been recognized and must now be seriously considered.

He pointed out that due to natural oxidation of the delta peat soil, the loss in topsoil is 1-3"/year. (This is a fact we knew.) This is manifested by the fact that the "ash" content of virgin peat is only about 10%, but the "ash" content of the delta topsoil is about 30%. That is, oxidation of the peat soil removes the organic material and leaves the residual mineral ash behind, thus concentrating it in the topsoil. Further, because of this 1-3" loss of topsoil each year, each Spring plowing "turns up" and exposes a 1-3" sheet of virgin peat which gets mixed in with the residual topsoil.

The importance of this continual oxidation as it relates to compost utilization is the ever-greater emergence and presence of plastic film. Plastic film has already been recognized to be a most unwanted component of the refuse and of the compost. Now it is brought home that the film will be an impossible constituent of the compost when applied to the Delta. Specifically, the compost will oxidize and thus will be lost. But the plastic film will not similarly be oxidized and lost. Rather, like the mineral or "ash" content of the original peat soil, it will become an ever more concentrated component of the residual material.

The message seems clear--a very high percentage of the plastic film will have to be removed before, during, or after the composting operation in order that the compost can be placed and utilized in the Delta. There must not be a gradual surfacing of excessive plastic film as the compost oxidizes and leaves behind only plastic film.

## COMPOST QUALITY SPECIFICATIONS

## ON

rch on compost quality has been concerned with the degree
zation required for use on the land as related to crop
ty in the year of application, or in the subsequent year.
e of compost for the Delta Islands, immediate use is not
and compost quality must be related to its environmental
lationship to wastes management, and agricultural viability.

specifications thus relate to the physical, chemical, bio-
d pollutional characteristics rather than to the agricultual
e material. These quality criteria are tenative, and
nown facts about compost. But it should be recognized
fication of the specifications will probably be needed,
e results of the proposed 3-year pilot study.

## CATIONS

of the composted waste material to be placed in the
ds shall conform to the following limits:

y Weight Bulk Density The bulk density of the dried
ids, without any moisture addition, shall be no greater
/ft$^3$, when tested by means of the Standard Proctor
Cylinder test.
sion: The University of California, Davis, research on
conducted this year (1973) has shown the dry solids
of compost to be 9-16 lbs/ft$^3$. The bulk density of the
st solids, when compacted in a Standard Proctor Comp-
nder Test, without added moisture, runs no more than
nless there is extraneous soil or sand mixed with the
ost. Thus the real purpose of this specification is
at if compost is paid for by finished tonnage, that
ot unfairly upped by mixing in dirt.

2. Particle Size Limits All compost particles shall pass through a 3/4" square opening screen, and at least 50%, but not more than 95%, by dry solids weight, of the compost shall pass through a 3/8" square opening screen.

Discussion: This specification is also partially conceived to prevent adding soil (or gravel particles larger than 3/8".) However, firstly, it is recognized that there should be a maximum particle size. The University of California compost was screened through a 3/4" sieve and the appearance is reasonably acceptable. Some 2-year old Houston compost was also sieved, apparently through a 1/4" sieve, and its appearance is much better. But the compost is not intended for home gardening, and does not need to be of perfect appearance, the 3/4" sieve therefore appears to be acceptable. The reason that at least 5% of the compost needs to be retained on the 3/8" sieve is so that the test of Specification 3, relating to plastic film, can be made.

3. Maximum Plastic Film Content Not more than 1%, by dry solids weight, of the compost passing the 3/4" screen and retained on the 3/8" screen, shall consist of plastic film, or hard plastic of any color other than black or brown.

Discussion To explain this requirement, one must first understand the phenomena of peat soil--or humus or compost--disappearance in the Delta Islands. Each year when a Delta Island farmer plows his land, he turns over about an 8" plow layer. 5 to 7" of that is the previously worked soil, but the bottom 1 to 3" is always a virgin peat. Thus during each crop year, the beginning 8" of topsoil shrinks to 5 or 7". The shrinkage or loss is due to the oxidation of the highly organic soil. This oxidation loss of the organic content is proven by the fact that the ash content of the virgin peat is only about 10%, but the ash content of the topsoil is 30 to 40%. The organic content has oxidized off, leaving the residual ash to become ever more concentrated.

This same situation will occur with compost, and one of the things left behind to ever increase in concentration will be the plastic film. The University study of composting was most enlightening; plastic film was noted within the raw refuse and sewage sludge mixture, but it was in no way an obvious component. As composting progressed, the nondegradable plastic film became a more and more obvious--and visually objectionable--part of the compost. It is

lt that the content of the plastic film must be kept to a minimum,
d 1% of the material retained on the 3/8" screen appears to be that
asonable minimum.

4. Biodegradability The compost shall be biologically well-
abilized. The measure of the compost stability shall be that
mly-packed, adequately and properly moistened compost, when placed
an insulated container of at least 1-cubic foot capacity, within
oom maintained at least 18°C, shall not heat up more than 5° C
imum at any point within the cubic foot, in a 24-hour period.
Discussion: There are several ways to measure the degree of
bilization of compost: 1) appearance, 2) odor, 3) final drop
temperature, 4) degree of self heating capacity, 5) remaining
unt of resistant decomposable matter, 6) rise in redox potential,
) oxygen uptake, 8) growth of Chactomuim gracile, 9) and the starch
t.[1] In practice the first three are what the operator would
to "feel" when the compost is ready. The fourth method-reheating
acity-has been chosen, however, as the best quantitative indicator
readiness.

t is proposed that the test consist of taking reasonably moistened
erial and packing it (by hand) within a polystyrene "ice chest".
lid would be put on and 24 hours later a thermometer would be
into it. If biological activity is significant, the temperature
ld rise significantly. A 5°C temperature rise is not very much,
would appear to indicate considerable stability to the compost.
t is recognized that this specification, probably more than any
the others, will be refined during the pilot study. However,
t is presently as valid, quick, reproducible, and meaningful as
thing else could be to measure relative stability and thus
eptability of the compost to be transported to the Delta islands.

5. Salt and Leachate Content The compost shall not contain
ssive amounts of salts or other soluble materials. Specifically,
quality of the compost shall be such that the electrical con-
ivity (EC) of an extract made from a filtrate using 10 ml
r per gram of dry solids compost, shall not exceed ________
imhos per centimeter (mmh/cm.)

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mposting, Clarence Golueke, Rodale Press, 1972.

Discussion: One of the critical problems in using compost in the Delta Islands is the possible pollution of the Delta waters due to leaching of irrigation water, and rainfall, through the placed compost. There is no answer to this as yet, both from a Regulation standpoint, and from the practical point of whether leachate quality has an effect upon the agricultural productivity of the land. Thus for the present, the quantity of allowable leachate is unknown, and must be determined from some University analysis.

However, the possible technique for determining the quantity of leachate is straightforward, and is patterned after the procedure for determining the salt content of a soil. Specifically, a definite quantity of water is mixed with the material to be tested, (Soil or compost), and the extract is measured with an electrical conductivity meter, the salt content of the filtrate being related to the millimho/cm conductivity of electricity through the slightly saline filtrate water. This same procedure is proposed here, although at present no specific value is given. However, as a comparison, it is known that fresh dairy manure has an electrical conductivity of its extract of 2 mmhos/cm, when 10 ml $H_2O$ are used per gram of dry solids. One would expect the conductivity of a compost extract to be less (less in the compost) than that for manure where salt is a component of the diet.

6. General Nuisance Limitations The completed compost shall not be so dry as to create dust when handled. Nor shall the compost be so moist that any drainage occurs. The odor shall not be other than can be described by "vacuum cleaner dust" or "freshly turned soil".

Discussion: The moisture content should be to where the material is basically moist enough not to cause dust, but not so wet as to cause drainage liquor, in a pile or draining from a truck. Actually, in the normal situation, the compost will tend to dry out more than to become excessively wet. In any event, moisture problems need not be serious with compost.

Odors also need not be serious. Fresh dry refuse has an unmistakable "garbage" odor and sewage sludge can smell like anything from sewage to a tarry, sweet, non-objectionable material. However, as composting proceeds the odor changes to that of vacuum cleaner ust, and a completely ripe, well-cured compost has the very pleasing dor of freshly turned earth.

## UGGESTED OPERATING SPECIFICATIONS FOR COMPOSTING

### NTRODUCTION

ne of the great concerns of the local citizenry is that wherever ne actual composting is conducted, it be conducted without nuisance o nearby residents. It is therefore appropriate that there be erational performance specifications. The following recommendaions are designed to eliminate, or to at least minimize the otential hazards of nuisance and pollution from the composting eration.

is important to recognize that these operational performance ecifications are not absolutes. They will not positively prevent isance under all conditions, but they contain penalty provisions at will quickly make it uneconomic for the composting contractor operate in anything but a nuisance-free manner. There is an alogy; most cities have 25 mph speed laws. These do not absolutel ntrol everyone from travelling faster than 25 mph, but the law kes it uneconomic to travel faster than the posted speed limit. too with the following operational specifications; they cannot sitively control all nuisance or hazards of operation, but olation carries a financial penalty that will cause compliance nuisance-free operation.

ch performance specification is spelled out in pseudo-ordinance pseudo-contract form. A discussion section follows each ecification which explains the rationale for the specification, d gives ideas on how the requirement might be met.

1 Prevention of Odors In conducting the composting operation, e Contractor shall perform in such a manner that objectionable ors do not occur. The measure of objectionableness shall be sted in the local citizenry, aided by municipal staff appraisals d scientific tests as are appropriate. The penalty for causing

objectionable odor conditions shall be $200/day for each day of objectionable odor production, and any fines shall be paid to the city.

Discussion: Odors from the composting operation will occur only when the refuse-sludge mass becomes anaerobic in itself, or when the anaerobic condition is being combatted by extensive turning and aerating. The anaerobic condition will develop only if the incoming refuse-sludge mixture is too wet and compacts, or the windrow turning equipment breaks down so that the intervals between turnings is too infrequent. It is also true that on a completely still (usually hot and humid) day, an otherwise too-dilute and non-objectionable odor condition may turn into an odorous situation.

The control of odors is obvious; the contractor must control the moisture content of the refuse-sludge mass as it turns to compost, and there must be adequate standby equipment available to keep the windrows turned on schedule. There also needs to be provision for extra turning when an incipient anaerobic-odorous condition is seen to be developing, and compost turning must also be conducted at times when air movement is away from areas of possible complaint.

The specification suggestshow odor measurement and penalty impostion might be done. Regrettably, gas and air analysis by even the best of today's scientific procedures and equipment has not been effective in quantifying odor components at the "parts per trillion" level--the level that can be detected by the human nose. However, a single citizen's complaint of odors may be a biased situation, and automatic penalty assessment based on one or a few chronic complainers is probably not in the best interest of anyone. It is therefore proposed that if or when there is a citizen's complaint, it be checked out by the community's Public Works and police departments. (Calls usually are first received by the Police). Upon the finding of a legitimate odor, it is recommended that the Contractor be immediately fined the $200/day, and be made to explain the situation. After all, he too knows there is an odor condition because he is right in the middle of it. The immediate fining and requiring a report on the cause should go a long way in preventing reoccurance. It is also suggested that the Contractor's report be duplicated and be sent to each complaintant; this would be a way to involve the local citizenry in the operation, and in understanding the difficulties.

2. Preventing Blowing Paper, Litter, and Dust Contractor shall operate the composting operation within an enclosure such that paper and other litter shall not be carried off the premises. Nor shall dust and other particulate matter, as measured by dustfall jars or other devices within 100 feet of the composting enclosure measure more than 25% more dustfall than similar devices 1000 feet from the enclosure.

Discussion: It is absolutely mandatory that the composting operation not create a waste paper and litter problem in the neighborhood. To prevent blowing paper, the composting operation needs to be conducted within an enclosure. For economy and overall effectiveness, it is proposed that the enclosure be 1" poultry netting, roof and sidewalls, with the roof being a cable-supported structure. 1" poultry netting will, of course, be effective in containing larger particles, although some small particles and dust can escape. However, particles less than 1" in size do not generally have favorable aerodynamic properties (confetti does not really travel well.) Further, such quantity of uniform-sized litter will not be especially obvious, if it exists at all.

Similarly, the dustfall measurement will be easily met if the Contractor maintains the compost windrows in the moist condition which is also required for optimum rate composting.

3. Runoff Water Control Contractor shall capture all rainfall or other free water falling on or occuring on the paved composting yard, and shall recycle or otherwise properly dispose of said water in order to prevent surface or underground water pollution.

Discussion: It is inferred that composting occurs on a paved yard--this is correct, and such paving is absolutely mandatory to prevent fly problems, prevent anaerobic conditions from developing in the base, and prevent infiltration of polluted water. For a 20-year project, the paving could be concrete, like a heavy-duty highway. Probably for the three-year demonstration project, an ashphaltic or bituminous paving is all that can be justified. Regardless, the windrows will cover only 50-60% of the yard, so rainfall will result in a runoff.